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NATIONAL DAM SAFETY PROGRAM. HUNTING CREEK DAM (INVENTORY NUMBE--ETC(U)
SEP 78 DACW31-78-C-0044
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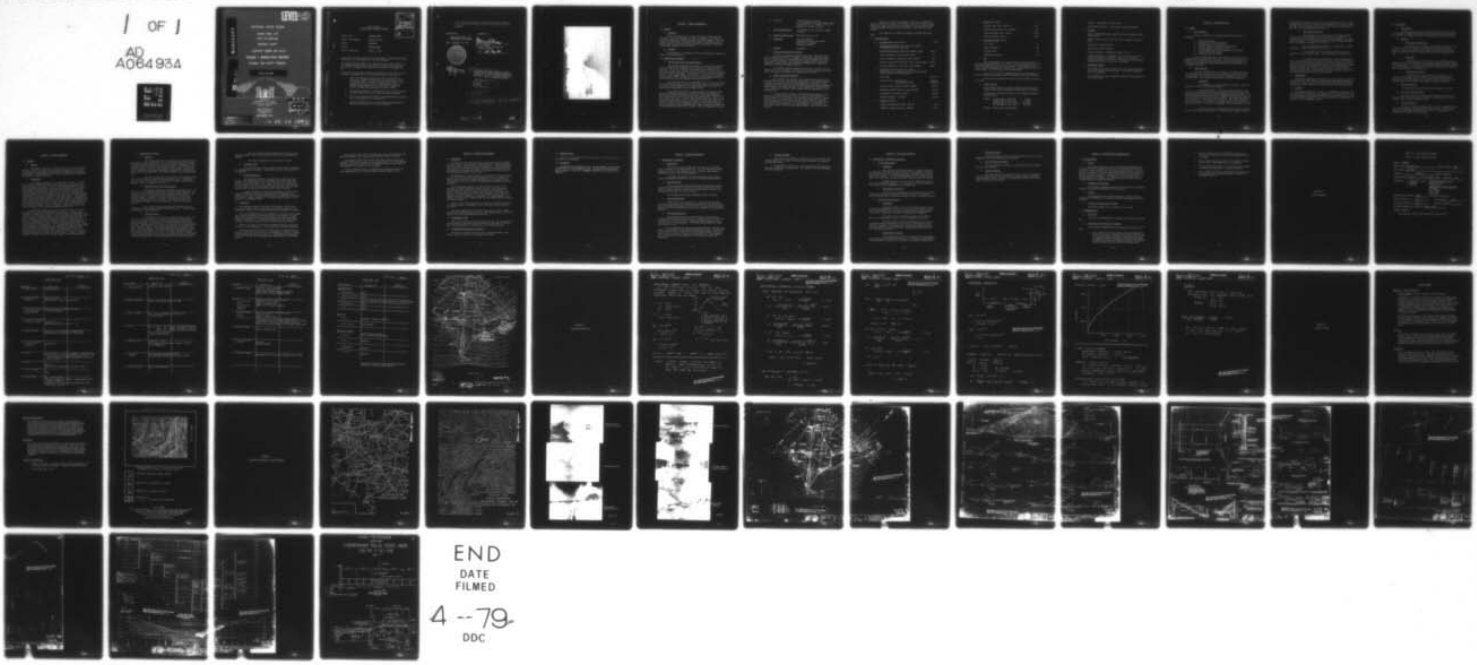

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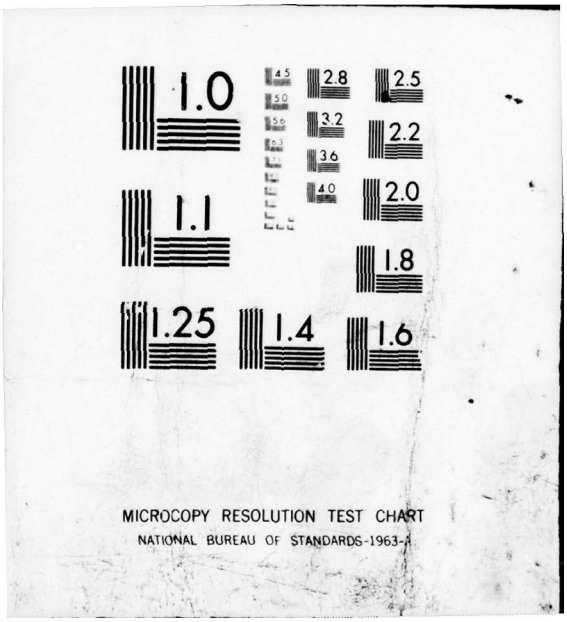
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LEVEL II (1)

POTOMAC RIVER BASIN

HUNTING CREEK DAM

STATE OF MARYLAND

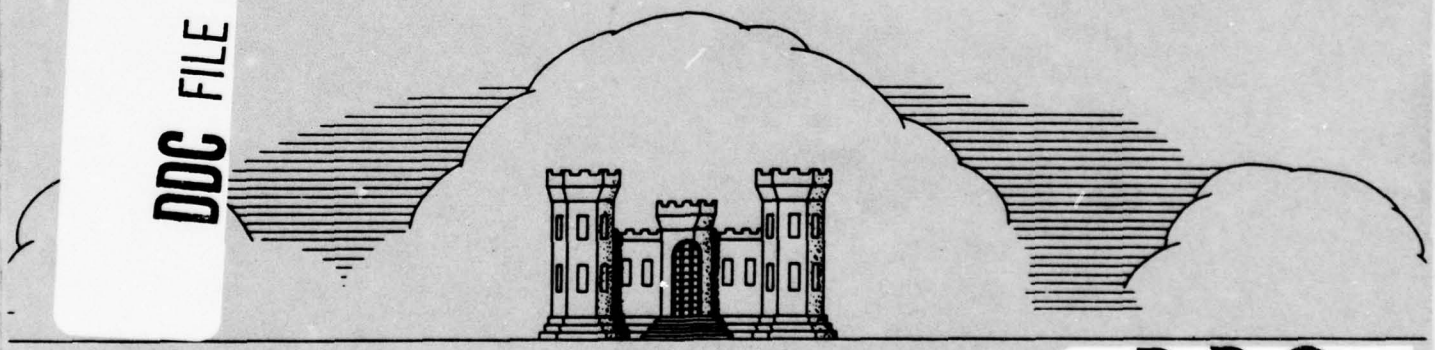
FREDERICK COUNTY

INVENTORY NUMBER NDS MD-58

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

DACW31-78-C-0044



Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland
by
BERGER ASSOCIATES, INC.
CONSULTING ENGINEERS
HARRISBURG, PA.

SEPTEMBER 1978

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	HUNTING CREEK
State & State Number:	MARYLAND, MD-58
County:	FREDERICK
Stream:	HUNTING CREEK
Date of Inspection:	August 2, 1978

Based upon the visual inspection, past performance, and available engineering data, the dam appears to be in good condition.

The spillway has the capacity for passing 33,410 cfs which exceeds the PMF (Probable Maximum Flood) peak inflow of 11,845 cfs by 22,565 cfs. The spillway is adequate for passing the PMF without overtopping the dam.

In order to continue the satsifactory performance of this facility, the following recommendations are presented for action by the owner:

1. That a monitoring and observation system be developed to measure the volume of seepage from the downstream toe and at all seepage points that may be revealed in the future. If changes in volume or clarity of the discharge occur, an engineering assessment should be made and if conditions dictate, remedial measures should be taken at once.

2. That the heavy growth on the downstream slope be controlled on a regular basis and that all brush and trees be removed.

3. That a close inspection be made of the downstream slope surface after recommendation No.2 is completed.

4. That the vegetative growth in the spillway outlet channel be removed and maintained in a cleared condition.

5. That a formal surveillance and downstream warning system be developed to be used during periods of intense or prolonged rainfall.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: September 22, 1978

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HENDRIK JONGSMA
ENGINEER
No. 5557E

APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 23 Sep 78

(6) National Dam Safety Program. Hunting Creek Dam (Inventory Number NDS-MD-58), Potomac River Basin, Frederick County, Maryland. Phase I Inspection Report.

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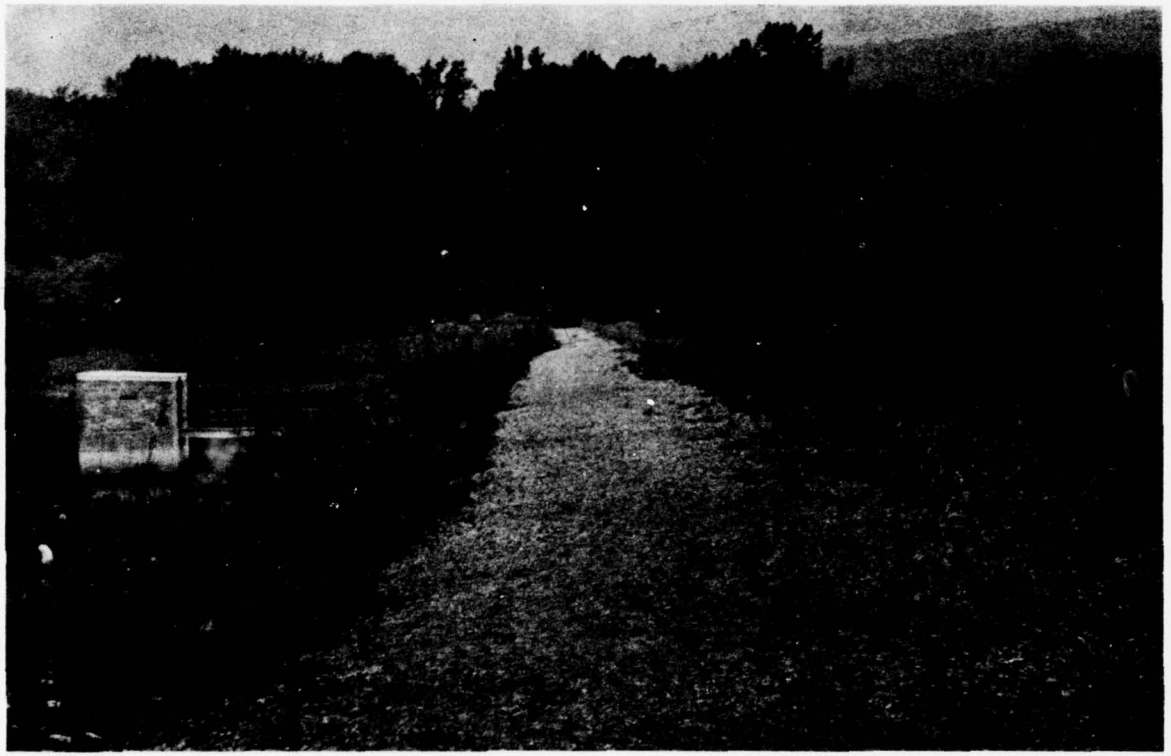


OVERVIEW

ABSTRACT

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States. The Phase I Inspection and Report are limited to a review of available data, a visual inspection of the dam site and basic calculations to determine the hydraulic adequacy of the spillway.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

ABSTRACT

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

The Hunting Creek Dam was designed for recreational purposes and is located in the Cunningham Falls State Park, Frederick County, Maryland. The dam is a 630 foot long earthfill structure with a 157 foot long concrete ogee spillway having a 16-foot by 1.4 foot deep rectangular slot near its center. The reservoir area, at elevation 1000, is 43 acres. The maximum height of the dam is 79 feet above the original stream channel. Water discharging over the spillway passes down over a natural rock chute to the concrete stilling basin below.

The upstream slope of the embankment (2.5H to 1V) is protected by a rockfill cover with a graded filter zone between the rockfill and the select rolled embankment. The downstream slope (2.5H to 1V) is covered with crown vetch, brush and small trees.

The intake structure is a concrete tower with upstream flow controls including three 36-inch gates at different elevations for intake and one 36-inch outflow control gate. The conduit leading from the control tower to the stilling basin is 48-inch R.C.P. There is no other outlet structure. A rock toe is provided along the length of the embankment below elevation 980. An 8-inch V.C. pipe toe drain is installed along the entire embankment length at the toe and discharges through a section of pipe perpendicular to the toe drain at a point 400± feet downstream from the axis of the dam. Refer to Appendix D, Plate V.

B.	Location:	Frederick County, Maryland U.S. Quadrangle, Blue Ridge Summit, MD-PA. Latitude 39°-32.6', Longitude 77°-27.5' (Appendix D, Plates I and II)
C.	Size Classification:	Intermediate (1,534 acre-feet, height 79 feet).
D.	Hazard Classification:	High (See Section 3.1.E)
E.	Ownership:	State of Maryland Department of Forests and Parks State Office Building Annapolis, Maryland
F.	Purpose:	Recreation

G. Design and Construction History

The State of Maryland engaged Buchart Horn, Consulting Engineers of Baltimore, Maryland, to prepare a feasibility study and report for the construction of an impounding dam at the Cunningham Falls State Park, Thurmont, Maryland. This study was completed and a report was submitted in August 1964, with favorable recommendations including the selection of the most suitable location.

Buchart-Horn prepared design plans and specifications for the construction of this project. The date of the original plans was October, 1966. The project was essentially completed late in 1968.

H. Normal Operating Procedures

This facility was designed as a recreational project for the Maryland Park Service. The care and maintenance of the swimming beaches and boating access areas dictates the operational procedures. Additionally, since these waters are stocked with trout, the Maryland Fisheries Administration has intense interest in the management of the operations. It is, therefore, a combined effort between the two departments in the operation plan.

For recreational purposes, the desired pool elevation of the reservoir is 1000.0 (measured at 999.9 at time of this inspection). This elevation is 0.8 foot below the spillway notch elevation of 1000.8. The pool level is regulated by using one of the intake gate controls and the outlet gate. The choice of which gate is used is guided by the water temperature requirement for fish management. For example, the lower gate is used during the warm summer months to provide cold water release.

There is a low flow requirement to maintain a minimum discharge to the natural stream. Accordingly, there is at least one gate open at all times to satisfy this requirement. The pool level seldom reaches spillway elevation, as this interferes with the beach maintenance.

The capability of complete drawdown is through the bottom gate.

1.3 PERTINENT DATA

A.	Drainage Area (square miles)	6.85
B.	Discharge at Dam Site (cubic feet per second) See Appendix B for calculations.	
	Maximum known flood at dam site (October, 1976)	1,690
	Outlet conduits at low pool Elev. 945.7	50
	Outlet conduits at normal pool Elev. 1000.8	220
	Spillway capacity at pool Elev. 1017.7 (top of dam)	33,410
	Spillway capacity at pool Elev. 1010 (design)	11,600
C.	Elevation (feet above mean sea level) Refer to Plate X, Appendix D, for as-built spillway elevation and top of dam elevation	
	Top of dam	1,017.70
	Spillway crest - Ogee Section	1,002.24
	Broadcrested section	1,000.80
	Upstream portal invert of outlet conduit	939.20
	Downstream portal invert of outlet conduit	936.25
	Streambed at centerline of dam	939.00
	Maximum tailwater - Estimate	944.00
D.	Reservoir (miles)	
	Length of maximum pool (Elev. 1017.7)	0.70
	Length of normal pool (Elev. 1000.8)	0.23

E. Storage (acre-feet)

Spillway crest (Elev. 1002.24)	845
Spillway notch crest (Elev. 1000.8)	771
Design surcharge (Elev. 1010.0)	1,263
Top of dam (Elev. 1017.7)	1,534

F. Reservoir Surface (acres)

Top of dam	68
Design surcharge	59
Spillway crest	46
Spillway notch crest	44

G. Dam

The dam embankment is a zoned earthfill structure with upstream and downstream slopes of 2.5H to 1V. Rockfill provides the cover on the upstream slope over its entire length. The downstream slope cover is impervious material to elevation 975.5 then rockfill to the toe of the slope. A ten foot berm is at elevation 980.0.

A cutoff core trench of impervious material extends down to the rock surface and a grout curtain is provided in the rock formation.

The top of dam elevation is 1017.7, and the width of the crest is 25 feet.

H. Outlet Conduit

Three 36-inch diameter reinforced concrete pipes upstream of control tower, each regulated by a sluice gate in the tower.

Downstream of the control tower is a 48" diameter reinforced concrete pipe.

Length:	36-inch pipe at Elev. 985	-	9 feet.
	36-inch pipe at Elev. 970	-	45 feet.
	36-inch pipe at Elev. 941.5	-	116 feet.
	48-inch pipe at Elev. 941.2	-	495 feet.

Closure: Three 36-inch sluice gates.

Access: Footbridge to intake tower.

Regulating facilities: sluice gates, manually operated.

I. Spillway

Type: uncontrolled, ogee shaped weir with rectangular broad-crested notch.

Length of weir: Ogee Section 141 feet. Length of notch -16 feet.

Ogee crest elevation 1002.24

Notch crest elevation 1000.8

Upstream channel: rectangular channel in rock.

Downstream channel: rectangular, cut in rock, chute curves to right, steepens and narrows as it descends 72 feet in a horizontal distance of 456 feet. The concrete stilling basin measures 86 feet, by 50 feet, by 5 feet deep.

J. Regulating Outlets

One 36-inch sluice gate on each of the three 36-inch diameter pipes inletting to the intake tower. One each at elevations 941.5, 970 and 985.

One 36-inch sluice gate on opening between the two chambers in the intake tower.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Data Available

The data contained in the Maryland DNR files include the following:

1. Feasibility Report.
2. Complete set of design drawings.
3. Specifications for construction.
4. Geologic report on subsurface explorations.
5. Test boring logs and test pit logs.
6. Field permeability test and pressure test records.
7. Field density test results.
8. Laboratory soil test data.

Design calculations were not available in the files for the embankment or the appurtenant structures. The feasibility report contains the most comprehensive information relative to the design, including site description, hydrology, geology, field explorations and preliminary sections.

B. Design Features

The design drawings show this facility to include the earthfill embankment, an uncontrolled ogee spillway, a spillway chute and stilling basin and an intake structure with discharge directly to the stilling basin. All features were observed during this inspection.

1. Embankment

The embankment is a zoned earthfill structure. Refer to Appendix D, Plate VI for typical sections.

The upstream slope is 2.5H to 1V rockfill surface. The rockfill is underlain by a two-foot thick mixed filter which separates the impervious central portion of the embankment from the rockfill. The downstream slope surface is composed of impervious material to elevation 975.5, below which the slope is again rockfill. The downstream slope is also 2.5H to 1V. A core trench is excavated to rock and is located on the upstream side of the dam axis and ranges from 20 feet to 35 feet in width at its base. A toe drain is provided. Refer to Appendix D, Plate V.

A grout curtain is provided beneath the cutoff trench and into the underlying rock formation. A short section of sheet piling is

indicated below the cutoff trench between stations 4+30 and 6+40. Refer to Appendix D, Plate IX. The top of the embankment is 25 feet in width and abuts with the natural ground on the right and the spillway wall on the left. Top of dam elevation is 1017.7.

2. Appurtenant Structures

The spillway for this facility is an uncontrolled ogee section with a crest elevation of 1002.24 (Plate X, Appendix D). A rectangular notch is located at the center of the spillway. The dimensions are 16 feet by 1.4 feet with the notch crest at elevation 1000.8, refer to Appendix D, Plates III, VII and X.

The spillway approach channel is equipped with a timber trash boom. Refer to Appendix D, Plate III.

The spillway chute is excavated in natural rock and terminates at the stilling basin. Refer to Appendix D, Plate IV and VII.

The intake structure houses four 36-inch sluice gates; three for intake and one for discharge control. The three intake gates are at elevations 940, 970 and 985. The discharge control is at the bottom of the tower on the downstream side of a baffeled chamber located inside the tower. The discharge is directly to the stilling basin through a 48-inch pipe. There is no other outlet control. Refer to Appendix D, Plate III, for photograph of intake structure and Plate IV for photograph of outlet pipe at stilling basin.

2.2 CONSTRUCTION

Information regarding the construction of this facility is limited. The Maryland DNR files contain several handwritten memos referring to visits to a number of construction projects of which the Hunting Creek Dam was one. These memos do not cover the total construction period.

2.3 OPERATION

This dam was constructed as part of a recreational facility at the Cunningham Falls State Park. The operation of the dam is controlled by the requirements for maintaining beaches, boating facilities, etc. The Maryland Fisheries Administration also has interest in the operation of the dam for fish management purposes.

2.4 EVALUATION

A. Availability

Although design calculations were not available in the files, the feasibility study, design plans, and field investigations available are suitable for judging the capacity and suitability of this facility.

B. Adequacy

1. Hydrology and Hydraulics

The hydrologic and hydraulic information contained in the feasibility report are suitable for evaluating the capacity of the project. These data include an area capacity curve up to design high water elevation and extensive computations to size the original spillway.

2. Embankment

The design plans and the result of the subsurface investigations, field tests, laboratory tests and the concepts presented in the feasibility report are adequate for assessing the design and the condition of the embankment. It is noted that there is minimal control of embankment through seepage on the abutments.

3. Appurtenant Structures

The design plans and details provide information for evaluating the adequacy of the spillway, and the intake and outlet features. These data, together with the hydrologic and hydraulic data are satisfactory for assessing the capacity of these structures.

C. Operating Records

No formal records of operations were available for review.

D. Post Construction Changes

The only reported post construction change for this facility was the modifications to the spillway with the construction of a rectangular notch. Refer to Section 2.1.B.2.

E. Sesimic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquate induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of this facility is good. The project of which this dam is a part is recreational in purpose. The visual checklist, noting observations made during this inspection is included in Appendix A. Photographs taken during the inspection are reproduced in Appendix D, Plates III and IV.

B. Embankment

The general appearance of the embankment is good. The abutments, with the original ground on the right and the spillway wall on the left appear to be sound. The top of the embankment has a stoned surface although some of the slope growth is encroaching on the surface at the edges. The downstream slope has a thick cover of weeds with occasional bushes and small trees near the toe. This condition made close observation of the slope surface very difficult. As near as could be determined, there was no seepage on the slope itself. The upstream slope cover is the exposed rockfill. The slope surface is irregular due to the large and variable size rock used in this area. Occasional areas of weed growth are also located on this slope. Both slopes, upstream and downstream appear stable, as there were no signs of cracks, settlement, bulges or sloughs. Unusual movement or other signs of distress were not observed in the areas downstream from the toe.

Seepage was detected at several locations. Refer to Sketch #1, Appendix A, where the embankment toe intercepts with the right abutment, a steady flow, estimated at about 25 gpm, is flowing away from the toe in a well defined channel. State representatives indicated that this hillside has numerous springs which could be one source of the water. Reference to the plan Appendix A, Sketch #1, shows this part to be near the embankment intercept with the original stream channel and very near the low point in the toe drain system which drains most of the right portion of the embankment. It is judged that both are contributing to the discharge. The second seepage point was observed at the toe drain outlet near the stilling basin. The plans show a drain pipe perpendicular to the toe drain pipe leading to this area. It is felt that this discharge is coming from the toe drain. In all, the seepage discharge indicates that the toe drain system is functioning properly.

C. Appurtenant Structure

1. Spillway

The existing spillway is a concrete ogee structure with a rectangular notch at the center. The left abutment is tied to exposed rock and the right abutment joins the left end of the embankment. Both junctures appear to be sound and in good condition. The notch in the spillway was the result of a modification to the original construction. It was required to accommodate operational problems with the reservoir level in the recreation area. All concrete appears to be in good condition.

The water surface level at the time of the inspection was 999.2 or about one foot below the spillway notch crest. The forebay area was wet but not covered with water and the timber trash boom was aground. Refer to Appendix D, Plate III.

2. Spillway Channel and Stilling Basin

The spillway channel is excavated into natural rock. Its surface is very irregular and provides a natural energy dissipator for the flow. Some brush and weed growth is located in this channel. The stilling basin is a concrete lined basin located at the end of the spillway channel. Erosion of the rough rock surface has partially filled the downstream end of the basin. The concrete walls of the stilling basin appear to be in good condition. Refer to Appendix D, Plate IV.

The 48-inch discharge pipe from the intake structure discharges into the stilling basin from the right side. It was flowing at the time of this inspection.

3. Intake Structure

A noticeable feature of the intake structure is that the level of its deck is about 11 feet below the top of the embankment. Access to the tower is from the slope of the embankment over a steel grated footbridge. The structure is a concrete cell from the bottom to the deck. The housing on top encloses the controls for the gates and is made of concrete block. Four 36-inch sluice gates are located in the tower. Three at different elevations 940, 970 and 985 provide variable depth intake capabilities. The intake structure contains two cells. The upstream side accepts the inflow. The center cell wall contains the fourth gate and controls the outflow which passes from the tower through a 48-inch diameter pipe to the discharge point at the stilling basin.

The State representatives indicated that all gates are operated between 8 and 10 times each year as part of the operation of the dam.

The overall appearance of the structure is good.

D. Reservoir Area

The reservoir area, being a State recreation park is composed of woodlands and some beaches. Sedimentation has not been reported to be a problem.

E. Downstream Channel

The downstream channel is described as a natural mountain stream. Trees and brush form the overbanks for the stone and rocky channel. The channel makes a 90° turn to the left as it leaves the stilling basin. The sides of the channel in this area, from the walls of the stilling basin to beyond the 90° turn, are well protected from heavy erosion by large stone boulders which line the surface.

Thurmont, Maryland is located approximately two miles downstream from this dam with many properties in the floodplain area. Damage, in the event of a dam failure, would be considerable and loss of life would be a high probability. The hazard classification for this facility is, therefore, "High".

3.2 EVALUATION

The observed condition of the dam at the present time is good. There are, however, several conditions that should be noted for consideration to assure the continued satisfactory performance of the dam.

The first consideration is the condition of the cover on the embankment slopes; especially the downstream slope. The presence of dense growth prevents the detection of any slope distress such as seepage, sloughs or settlement. It is deemed advisable that this cover be controlled on a regular basis and that all brush and trees be removed.

There is no record of the volume of seepage observed at the downstream toe of the embankment or at the end of the toe drain discharge.

Consideration should be given to monitoring the quantity and turbitidy of flow from all known points of discharge on a regular schedule noting quantity and clarity of the water. This applies to those areas at or below the toe of the embankment and upstream from the stilling basin.

The spillway outlet channel contains some brush and weed growth and should be cleared. Also loose eroded materials should be removed.

In conjunction with these records, the water surface level in the reservoir should also be noted so that an evaluation of all contributing factors can be made in the event of a dramatic change in flow volume or the appearance of turbidity in the discharge.

If such changes do arise, an engineering investigation should be made immediately and if indicated remedial measures taken at once.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The dam is part of the recreational facilities of the Cunningham Falls State Park. The operation of the facility is shared by the Maryland Park Service and the Fisheries Administration. The main purposes of the dam are to provide for public recreation on the lake and along the beaches and to provide the proper environmental condition for the fish management program on this stream.

The operation of the dam involves the control of the water surface of the reservoir lake area, proper discharge of water to maintain a minimum flow in the water course downstream and the release of water from different levels to satisfy the temperature requirements for fish management.

For recreational purposes, the desired pool elevation of the reservoir is 1000.0 (measured at 999.9 at time of this inspection). This elevation is 0.8 foot below the spillway notch elevation of 1000.8. The pool level is regulated by using one of the intake gate controls and the outlet gate. The choice of which gate is used is guided by the water temperature requirement for fish management. For example, the lower gate is used during the warm summer months to provide cold water release.

There is a low flow requirement to maintain a minimum discharge to the natural stream. Accordingly, there is at least one gate open at all times.

The State representatives indicate that records of flow, temperature, Ph and dissolved oxygen are made from samples taken at a low flow notched weir located downstream from the dam.

4.2 MAINTENANCE OF DAM

There is no regular maintenance program for the dam. The gates are operated eight to ten times a year during the normal operation of the dam. Other maintenance is carried out on an as-required basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

The gates in the inlet control tower are operated eight to ten times a year as required in the operatin of the dam.

4.4 WARNING SYSTEM

There is no formal downstream warning system at this facility in the event of an emergency.

4.5 EVALUATION

The operational procedures of this dam are adequate to serve the recreational and fish management needs. The gates are operated frequently enough to insure the drawdown capability in the event of an emergency.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

There were no design hydrograph, flow routing or discharge curves contained in the Maryland DNR file. The file contained an area-capacity curve up to the design high water elevation, and extensive computations to size the original spillway.

A spillway rating curve has been developed for this report using the information contained in the file on the spillway revision.

B. Experience Data

In the period since Hunting Creek Dam was completed in 1968, there have been three major storms; 1972, 1975 and 1976, which have caused the water level to rise to about two feet above the top of the spillways ogee section (El. 1002.24) crest.

The spillway passed these discharges without difficulty.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event. The gate operation during high pool levels is prohibited due to the low elevation of the operators platform.

D. Overtopping Potential

Hunting Creek Dam has an overall height of 79 feet above streambed and a maximum storage capacity of approximately 1534 acre-feet calculated to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (See Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam with the above classifications is the Probable Maximum Flood (PMF). The PMF peak inflow for this site is 11,800 cfs and the spillway capacity with the water level at the top of the dam is about 33,400 cfs. This indicates that the potential for overtopping of the dam does not exist (See Appendix B).

E. Spillway Adequacy

Since the PMF of 11,800 cfs peak inflow is less than the total spillway capacity of 33,400 cfs, the spillway is adequate for passing the PMF peak inflow.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

There were no visual observations of cracks, sloughage, or settlement that would indicate distress in the embankment structure. The heavy brush cover on the downstream slope prevented close examination of the surface. A follow-up examination will be in order by the owner after the brush and other growth has been controlled and removed.

Seepage observed at the toe of the embankment is clear and is not considered excessive. It is judged not to have influence on the stability of the embankment at the present time.

2. Appurtenant Structures

From the visual appearance, the spillway, spillway outlet channel and the intake tower are structurally sound. There was no serious deterioration or distress noticed in any of the exposed concrete.

B. Design and Construction

1. Embankment

The slope ratios of 2.5H to 1V for this dam are typical of earth dam embankments of this type. The feasibility report and the field and laboratory soil test data indicate that the design engineer used current engineering techniques in designing the embankment.

Grouting of the rock foundation reduces the possible source of seepage under the dam. Refer to Appendix D, Plate IX.

Internal seepage control was provided and a toe drain is included; however, provisions for control of through seepage on the abutment is minimal. The observations during the inspection indicate that the drainage system is operating. Engineering calculations were not available in the files.

2. Appurtenant Structures

The design plans provide the information for evaluating the stability of the concrete structures. The details of these features indicate adequate design and the stability is considered satisfactory.

C. Operating Records

Formal operating records, other than the data relative to fish management, are not available for this facility.

D. Post Construction Changes

The post construction change to this dam involves the modification to the spillway.

E. Seismic Stability

This dam is located in Seismic Zone No.1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations, studies, etc., were made to confirm this conclusion.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, review of design drawings and engineering data and the operational history of this facility indicate that the dam is in good condition and functioning satisfactorily. The spillway has the capacity for passing more than the PMF and is considered adequate. Refer to Section 5. Seepage does exist at several points but are not considered a threat to the safety of the dam at this time. Recommendations are presented for quantifying this condition and maintaining records for future evaluations.

B. Adequacy of Information

The available engineering data and design plans are considered adequate for making an assessment of this facility.

C. Urgency

The recommendations presented below deal with the ongoing satisfactory performance of the dam and should be implemented as soon as possible.

D. Necessity for Additional Studies

Additional studies are not indicated at this time.

7.2 RECOMMENDATIONS

A. Facilities

There are no recommendations to improve the facilities at this dam.

B. Operation and Maintenance Procedures

The following recommendations are presented for action by the owner.

1. That a monitoring and observation system be developed to measure the volume of seepage from the downstream toe and at all seepage points that may be revealed in the future. If changes in volume or clarity at the discharge occur, an engineering assessment should be made and if conditions dictate, remedial measures should be taken at once.

2. That the heavy growth on the downstream slope be controlled on a regular basis and that all brush and trees be removed.

3. That a close inspection be made of the downstream slope surface after recommendation No.2 is completed.

4. That the vegetative growth in the spillway outlet channel be removed and maintained in a cleared condition.

5. That a formal surveillance and downstream warning system be developed to be used during periods of intense or prolonged rainfall.

APPENDIX A

VISUAL INSPECTION

CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. MD-58

NAME OF DAM Hunting Creek HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION Frederick COUNTY, MARYLAND

INSPECTION DATE 8-2-78 WEATHER Cloudy - Warm TEMPERATURE 70's

INSPECTORS: H. Jongsma, R. Houseal
R. Shireman,
R. Bartlett

Md. Fisheries Administration
Howard Stinefelt
Susan Rivers
Department Of Natural Resources
Jeff Smith
Tom Moynaham
Dusty Moore
Jane Wagner

NORMAL POOL ELEVATION 1000.8 AT TIME OF INSPECTION

BREAST ELEVATION 1017.7 POOL ELEVATION 999.9

SPILLWAY ELEVATION 1002.24 TAILWATER ELEVATION

MAXIMUM RECORDED POOL ELEVATION 1004.2 (1976)

GENERAL COMMENTS:

Pool Elevation - Control Tower Deck Elev. minus 81-1/2"

DAM NO. NAD MD-58

VISUAL INSPECTION

EMBANKMENT	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SURFACE CRACKS	None detectable .	
B. UNUSUAL MOVEMENT BEYOND TOE	None detectable. Dense growth - small trees and weeds.	
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Could not observe closely due to very heavy weed growth.	
D. VERTICAL & HORIZONTAL ALIGNMENT OF CREST	Horizontal - o.k. Vertical checked by lock level - O.K.	
E. RIPRAP FAILURES	None detectable - growth on upstream slope. Upstream slope irregular due to large stone.	
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Satisfactory.	
G. SEEPAGE	Right abutment - at toe of embankment - steady flow from rock - appears to be outlet from rock toe drain. Wet areas in low lying sections downstream from the toe. Est. at 25 gpm.	
H. DRAINS	Rock toe. Outlet pipe 8" downstream of toe 200' - 300'.	
J. GAGES & RECORDER	None.	
K. COVER(GROWTH)	Top - stoned surface. Upstream - dumped rock surface - heavy weed growth at several locations. Downstream - very thick and heavy weed cover, some small trees near toe.	

DAM NO. NAD MD-58

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Top deck at Elev. 1006.0	
B. OUTLET STRUCTURE	Outlet into stilling basin. 48" pipe.	
C. OUTLET CHANNEL	None - Outlet discharge is directly into stilling basin.	
D. GATES	Inv. El. 983.5 - 36" - Intake + one outlet at bottom. 968.5 - 36" - Intake + one outlet at bottom. 940.0 - 36" - Intake + one outlet at bottom. Dual outlet control gate + small floater valve.	
E. EMERGENCY GATE	Lower gate - outlet . Use is summer for cold water release to satisfy fish management.	
F. OPERATION & CONTROL	Fish management and beach control. All valves are operated 8 to 10 times a year.	
G. BRIDGE (ACCESS)	Steel with grate deck.	

DAM NO. NAD MD-58

VISUAL INSPECTION

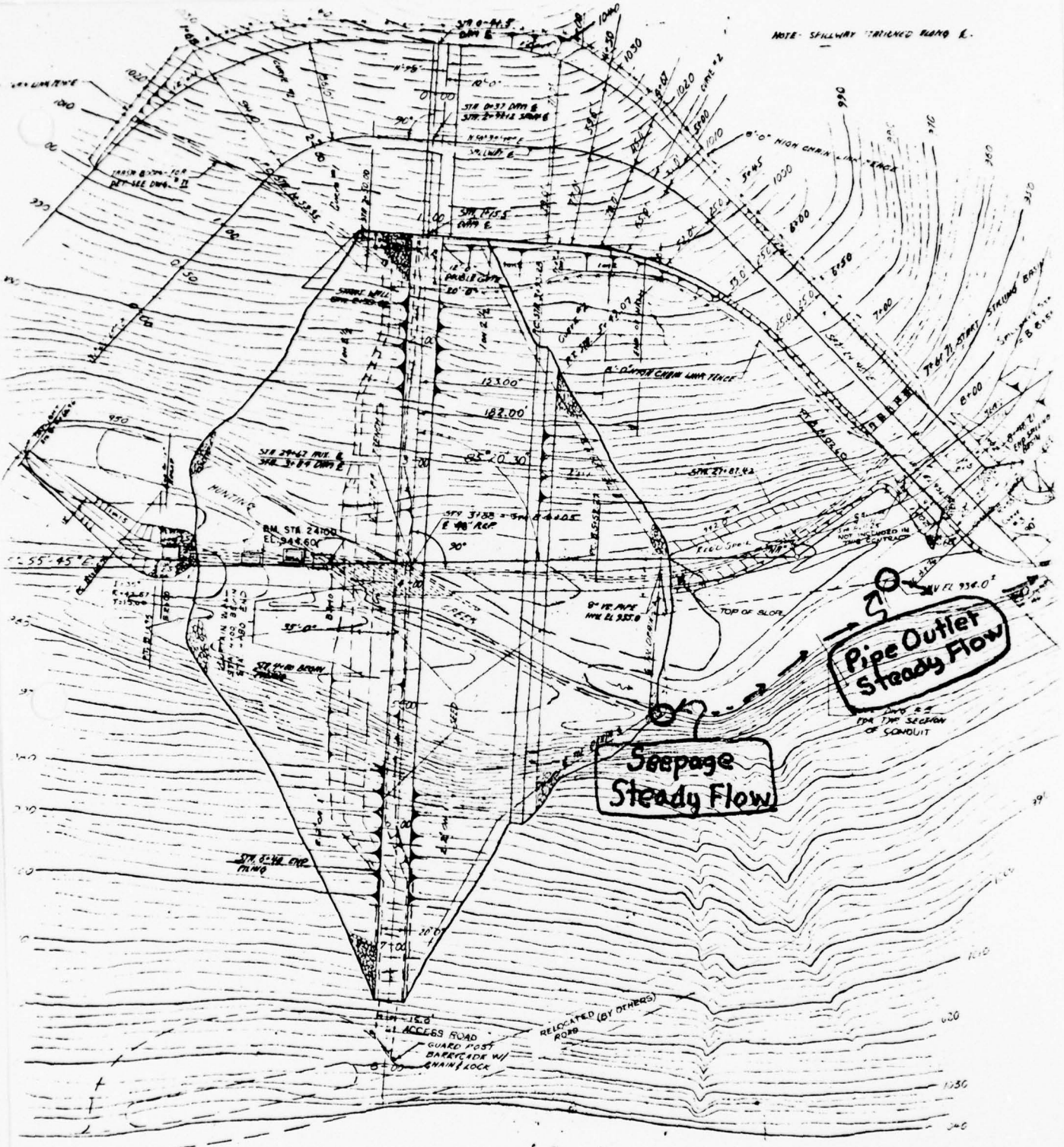
SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	From left side of reservoir. Left wall excavated rock. Heavy timber trash boom across approach. Water below spillway and notch crest.	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Concrete ogee with notch in center. Abutments: Left - rock. Right - Concrete wall. Appear to be in good condition.	
C. DISCHARGE CHANNEL Lining Cracks Stilling Basin	Lining is excavated into natural rock. Left wall rock. Right - concrete wall. Stilling basin at end of rock spillway channel. Large diameter pipe (48") discharging from Rt. stilling basin (low flow control from intake structure). Small trees & brush growing in the channel among rocks.	
D. BRIDGE & PIERS	None in spillway area.	
E. GATES & OPERATION EQUIPMENT	No gates. Notched spillway.	
F. CONTROL & HISTORY	Approximately 2.0'± flow over spillway weir in 1976.	

DAM NO. NAD MD-58

VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
INSTRUMENTATION		
Monumentation	None	
Observation Wells	None	
Weirs	None for seepage (low flow downstream of stilling basin).	
Piezometers	None	
Other	None	
RESERVOIR		
Slopes	Woodland - Recreation Beaches.	
Sedimentation	None reported.	
DOWNSTREAM CHANNEL		
Condition	Natural mountain stream 90° turn below stilling basin.	
Slopes	Woodland.	
Approximate Population	Thurmont.	
No. Homes	Thurmont.	

Low flow notched weir located downstream records temperature, dissolved oxygen and Ph.



SCALE 1" = 40'

SKETCH # 1

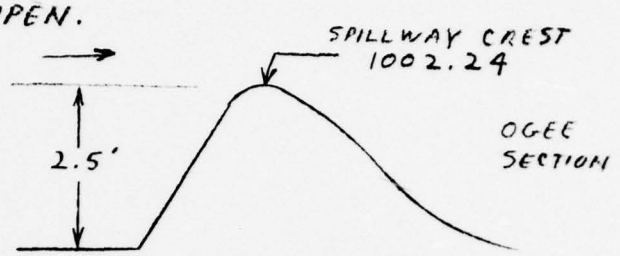
APPENDIX B

HYDROLOGY/HYDRAULICS

BY RLS DATE 8/10/78 **BERGER ASSOCIATES** SHEET NO. 1 OF 6
CHKD. BY DJK DATE 9/15/78 PROJECT D8270
SUBJECT HUNTING CREEK DAM

MAXIMUM KNOWN FLOOD AT DAMSITE

THE DAM CARETAKER RECALLED THAT ON THREE OCCASIONS, IN 1972, 1975 AND 1976, THE WATER REACHED A LEVEL ABOUT 2' ABOVE THE TOP OF THE SPILLWAY CREST, AND SLUICE GATE WAS OPEN.



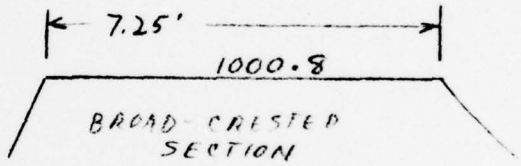
L = 157' TOTAL
16' BROAD-CRESTED
141' OGEE

C = 3.52
(FROM COMPUTATION BY DESIGNER BASED ON "DESIGN OF SMALL DAMS" METHOD. COMPUTATION ADEQUATE.)

H = 2' OGEE
= 3.44' BROAD-CREST

$Q_o = C L H^{3/2}$

$= 3.52 \times 141 \times 2^{3/2}$
$= 1404$ CFS



USE $C = 2.8$ (KING'S HDBK, TBL 5-3)

$Q_B = C L H^{3/2}$

$= 2.8 \times 16 \times 3.44^{3/2}$
$= 286$ CFS

$Q_{TOTAL} = 1404 + 286 = 1690$ CFS OVER SPILLWAY

NOTE: SURVEY ERROR EXISTED AT TIME OF DESIGN AND CONSTRUCTION. ELEVATIONS ARE TAKEN FROM CONSTRUCTION DRAWINGS AND MAY NOT BE ACCURATE.

BY NLS DATE 8/10/78 BERGER ASSOCIATES SHEET NO. 2 OF
CHKD. BY DJF DATE 9/15/78 PROJECT D8270
SUBJECT HUNTING CREEK DAM

DISCHARGE THROUGH OUTLET WORKS

HEAD REQUIRED TO DISCHARGE 220 CFS

48" DIA. PIPE

ORIFICE FLOW = $CA\sqrt{2gH}$ $C = 0.6$

$$H = \frac{(220/CA)^2}{2g} = \frac{\left(220/.6 \times \frac{\pi 4^2}{4}\right)^2}{64.4} = 13.2'$$

36" DIA. SLUICE GATE

ORIFICE FLOW = $CA\sqrt{2gH}$ $C = 0.6$

$$H = \frac{(220/CA)^2}{2g} = \frac{\left(220/.6 \times \frac{\pi 3^2}{4}\right)^2}{64.4} = 41.8'$$

3-36" DIA. PIPES

ORIFICE FLOW = $CA\sqrt{2gH}$ $C = 0.6$

$$H = \frac{(220/3CA)^2}{2g} = \frac{\left(220/3 \times .6 \times \frac{\pi 3^2}{4}\right)^2}{64.4} = 4.6'$$

ELEV. OF 48" PIPE CENTER = 941.2

941.2 + 13.2 + 41.8 + 4.6 = POOL ELEV.

= 1000.8'

HEAD REQUIRED TO DISCHARGE 50 CFS

48" DIA. PIPE $L = 495$

$\Delta H = 939.2 - 936.25 = 2.95$

$S = 2.95/495 = .00596$

BY RLS DATE 8/14/78 **BERGER ASSOCIATES** SHEET NO. 3 OF 6
CHKD. BY DJC DATE 9/15/78 PROJECT D 8270
SUBJECT HUNTING CREEK DAM

$$Q = \frac{1.486}{N} A R^{2/3} S^{\frac{1}{2}}$$

$N = .015$
$R = 1$

$$Q_{FULL} = \frac{1.486}{.015} \times \frac{\pi 4^2}{4} \times 1 \times (.00596)^{\frac{1}{2}}$$

$= 96.1$

$50/96.1 = 52\%$ OF FULL DISCHARGE
52% OF FULL DEPTH

$.52 \times 4 = 2.08$ USE 2.1' DEEP

$939.2 + 2.1 = 941.3'$

36" DIA. SLUICE GATE
ORIFICE FLOW $= CA\sqrt{2gH}$ $C = 0.6$

$$H = \frac{(50/CA)^2}{2g} = \frac{(50/.6 \times \frac{\pi 3^2}{4})^2}{64.4} = 2.2'$$

36" DIA. PIPE
ORIFICE FLOW $= CA\sqrt{2gH}$ $C = 0.6$

$H = 2.2'$

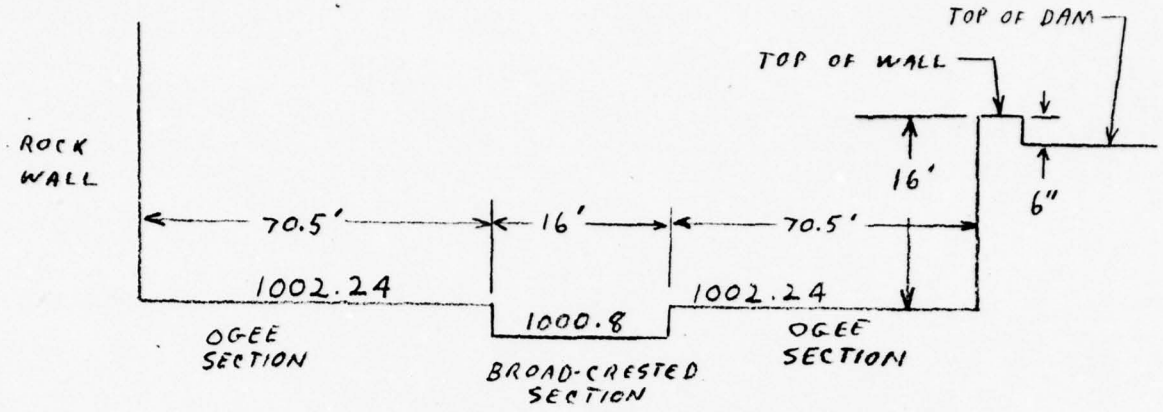
ELEV. OF HEAD ON 48" PIPE $= 941.3'$

$941.3 + 2.2 + 2.2 =$ POOL ELEV.

$= 945.7$

BY RLS DATE 8/14/78 **BERGER ASSOCIATES** SHEET NO. 4 OF 12
CHKD. BY DJL DATE 9/5/78 PROJECT D8270
SUBJECT HUNTING CREEK DAM

SPILLWAY CAPACITY



$Q_o = C L H^{3/2}$

$= 3.52 \times 141 \times (15.5)^{3/2}$
$= 30287$ CFS

$Q_B = C L H^{3/2}$

$= 2.8 \times 16 \times (16.94)^{3/2}$
$= 3123$

$Q_{TOTAL} = 3123 + 30287 = 33410$

CHANNEL CAPACITY APPROX. 50' DOWNSTREAM OF CREST.

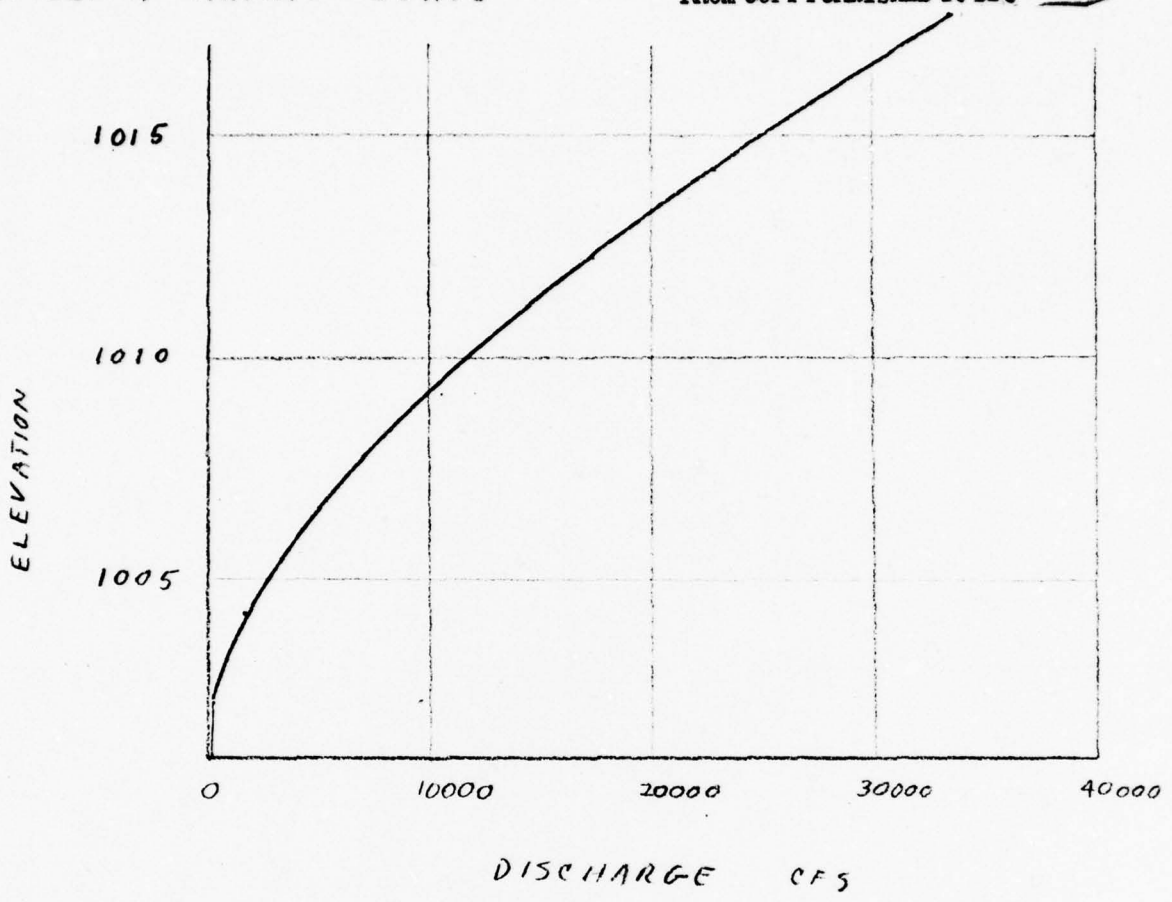
CHANNEL BOTTOM = 996.71
TOP OF WALL = 1006.0
H = 9.29
S = 5% N = 0.045
WIDTH = 157' A = 1458.5 R = 8.31

$Q = 1.486/N \times A \times R^{2/3} \times S^{1/2}$

$Q = \frac{1.486}{.045} \times 1458.5 \times (8.31)^{2/3} \times (.05)^{1/2} = 44180$ CFS

BY RLS DATE 8/14/78 **BERGER ASSOCIATES** SHEET NO. 5 OF 6
CHKD. BY DJR DATE 9/15/78 PROJECT D 8270
SUBJECT HUNTING CREEK DAM

SPILLWAY RATING CURVE



SIZE CLASSIFICATION

MAXIMUM STORAGE = 1534 AC-FT
MAXIMUM HEIGHT = 79 FT
SIZE CLASSIFICATION IS "INTERMEDIATE"

HAZARD CLASSIFICATION

THE DOWNSTREAM CHANNEL FLOWS THROUGH THE TOWN OF THURMONT. FAILURE OF THE DAM WOULD PROBABLY CAUSE LOSS OF LIFE AND PROPERTY. USE "HIGH."

RECOMMENDED SPILLWAY DESIGN FLOOD

FOR A DAM WITH THE ABOVE CLASSIFICATIONS THE RECOMMENDED SDF IS THE PROBABLE MAXIMUM FLOOD.

BY ALS DATE 2/4/78 BERGER ASSOCIATES SHEET NO. 6
CHKD. BY DJR DATE 2/5/78 PROJECT D 8270
SUBJECT HUNTING CREEK DAM

PMF

PMF OBTAINED FROM CORPS OF ENGINEERS,
BALTIMORE DIST. FOR DRAINAGE AREA = 6.85 SQ. MI.

PEAK Q = 1732 CSM
= 11845 CFS

RUNOFF = 32.72 IN.
= 11950 AC-FT

$$\frac{\text{MAX. DISCHARGE}}{\text{PEAK INFLOW}} = \frac{33410}{11845} = 2.82$$

THE SPILLWAY SHOULD PASS A FLOW EQUAL TO THE PMF PEAK INFLOW WITH ABOUT 7.5 FEET OF FREEBOARD

APPENDIX C

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Names: Catoctin Formation, Loudon Formation.

Lithologies: The Catoctin Formation is a complex of metamorphosed volcanic rocks. In the vicinity of the dam, the most common type is green to greenish gray, very fine grained, massive to well cleaved metabasalt, which is locally porphyritic, with inset crystals of white to light greenish gray feldspar. The Loudon Formation is a conglomerate, composed of quartz pebbles in a greenish gray quartzite matrix, interbedded with greenish gray, medium grained quartzite. Locally, at the base of the Loudon, is a grayish blue to dark gray phyllite.

According to the geologic map of the Blue Ridge Summit Quadrangle (Ref.1) the dam, and part of the reservoir are underlain by porphyritic metabasalt. Core boring logs, however, indicate the presence of quartzite on the southeast side of the valley. This is probably an infolded bit of Loudon that was too small to map at 1:24,000 scale.

Structure

The valley of Hunting Creek is just west of the axis of the South Mountain Fold, a complex anticline, with many smaller subsidiary folds. Bedding and cleavage strike about N40°E in this area. Cleavage dips 50°SE. The contact noted in the core logs between the quartzite and metabasalt dip about 15°SE. The cleavage direction apparently controls the course of Hunting Creek at the dam site.

Overburden

On the northwest side of the valley, where the bedrock is metabasalt and is relatively thin. From the stream channel to the southeast, there is colluvium, consisting of silty clay and weathered quartzite boulders, 12 to 50 feet thick. Below this, there is 30 to 50 feet of weathered quartzite. The holes which penetrated the contact indicate that the metabasalt was weathered along the contact.

Aquifer Characteristcs

The metabasalt has essentially no porosity and permeability. Ground water movement is entirely along cleavage planes and fractures, which are generally tight and movement is limited. The Loudon is also of very limited permeability, but there can be fairly free movement of ground water on fractures and cleavage, especially in the weathered zone. The deep weathering along the contact between the quartzite and the metabasalt, noted above, indicates that this is a zone of ground water movement.

Discussion

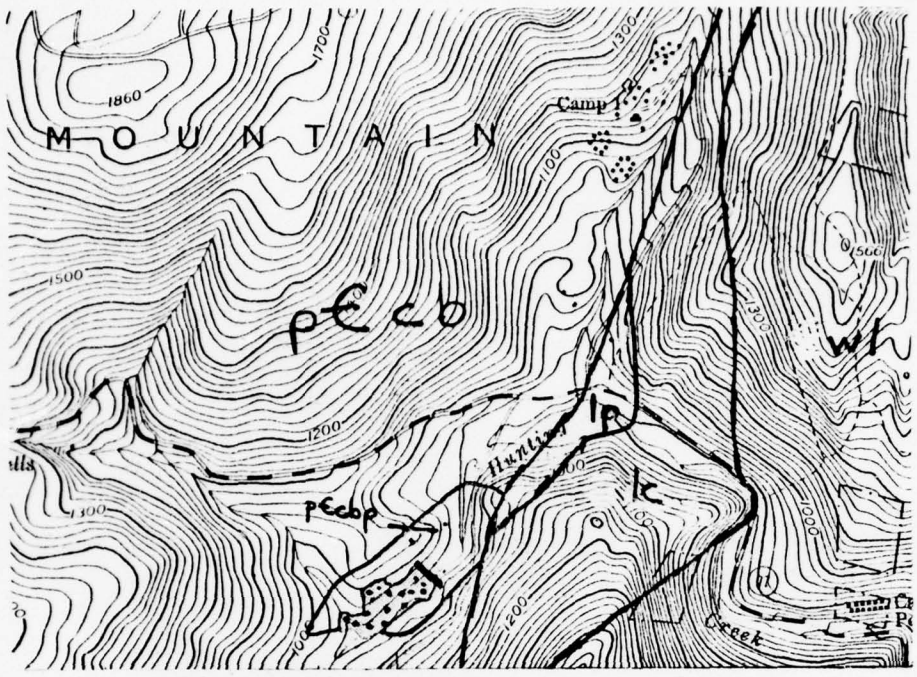
The zone of above normal permeability, in the contact between the two rock types, was recognized in the design of the dam. Sheet piling and extra deep grouting were provided in this area. The rock below this is fresh and only limited movement along cleavage and fractures would be possible. The minerals of the rocks are essentially insoluble, and would not be affected by ground water movement.

Sources of Information

1. Fauth, J.L. (1977). "Geologic Map of the Catoctin Furnace and Blue Ridge Summit Quadrangles". Maryland Geological Survey.

2. Core boring logs in file.

GEOLOGIC MAP - HUNTING CREEK DAM



(geology from Blue Ridge Summit Quadrangle, Geologic Map, 1977- Md. Geol. Surv.)

wl	Weverton Quartzite, lower member
lc	Loudoun Fm., conglomerate member
lp	Loudoun Fm., phyllite member
pEcbp / pEcb	Cotoctin Fm. pEcbp - porphyritic metabasalt

SCALE 1:24000

1 0 1 MILE

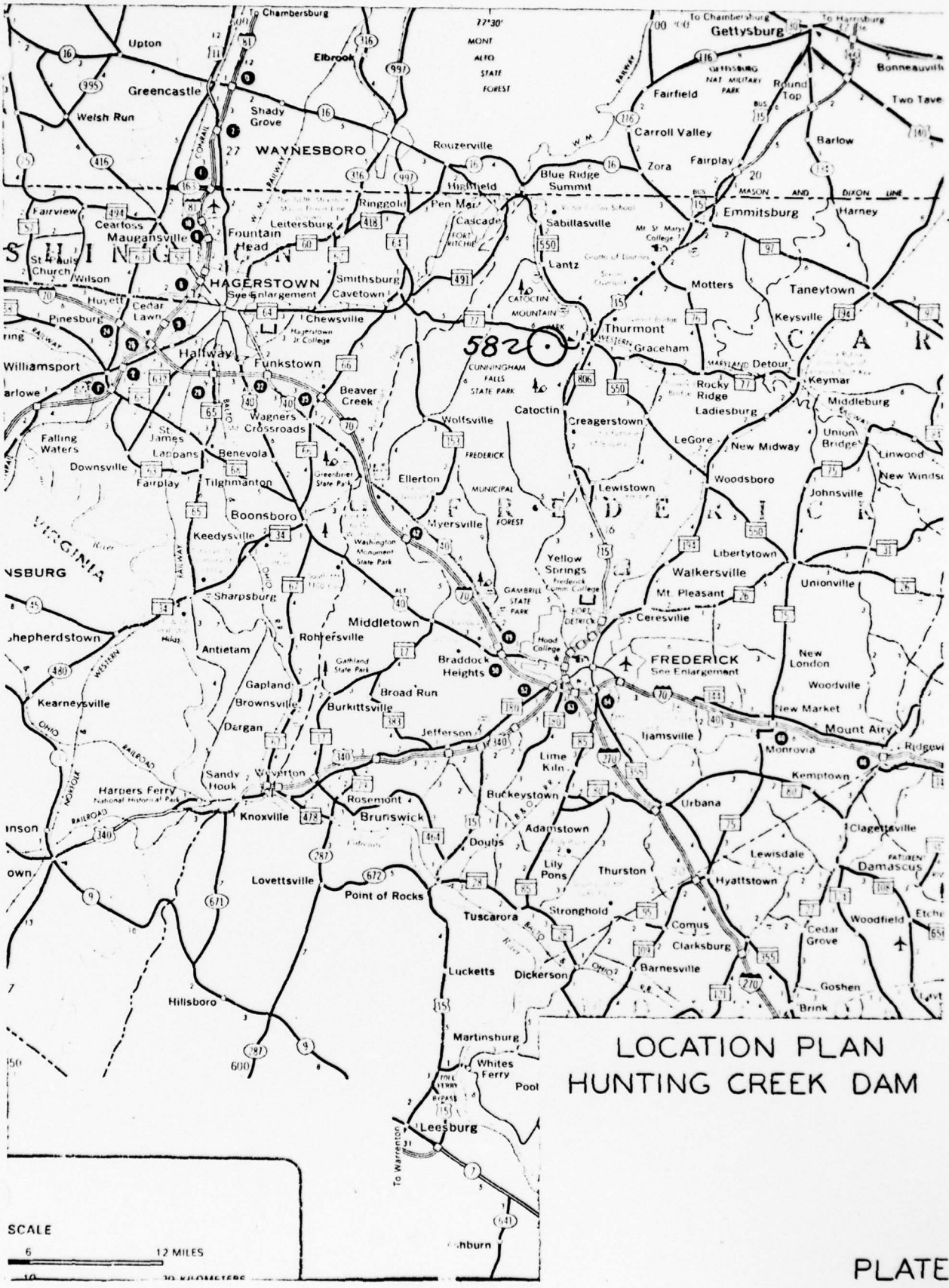
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS

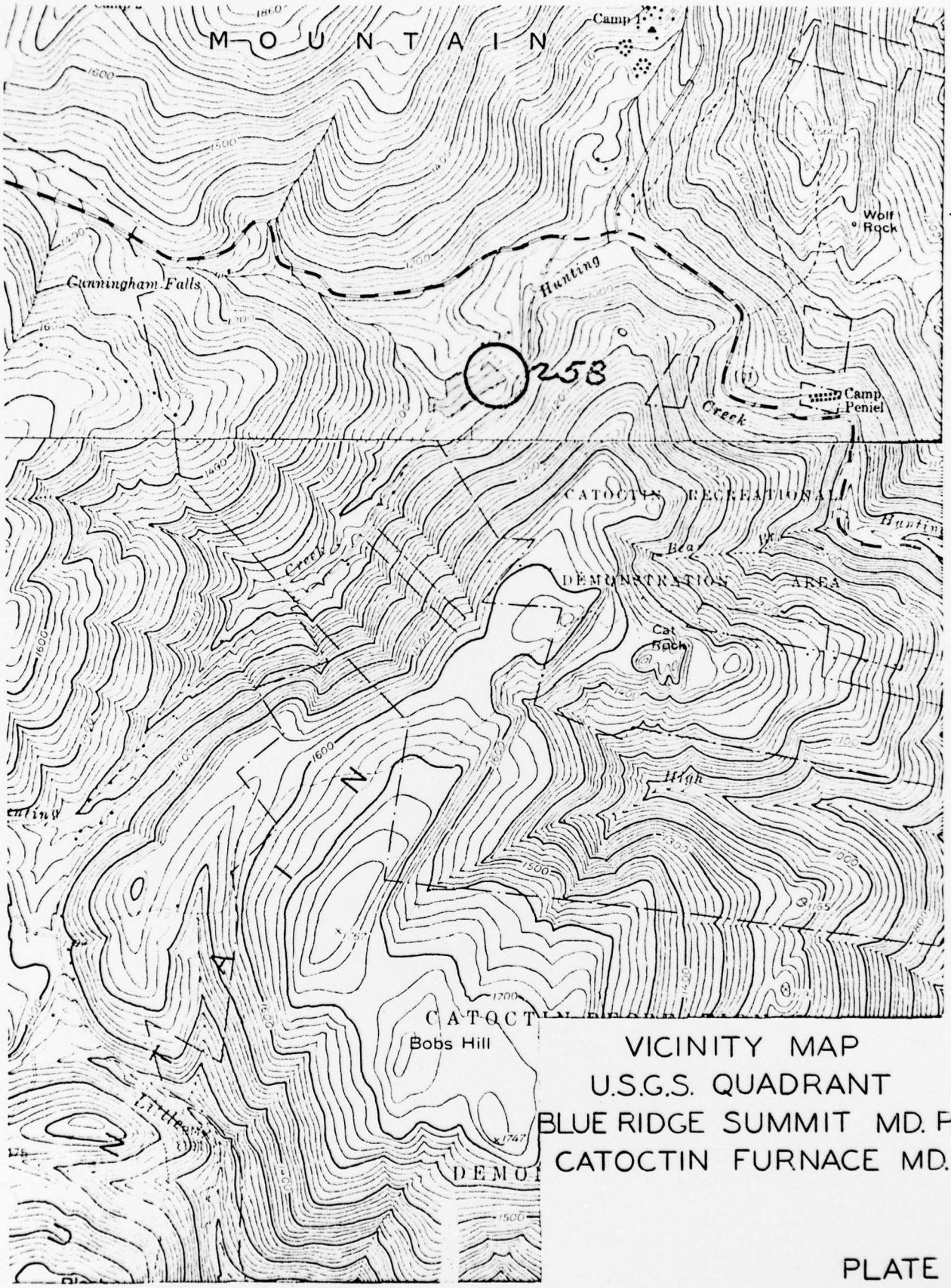
APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS



LOCATION PLAN
HUNTING CREEK DAM

PLATE 1

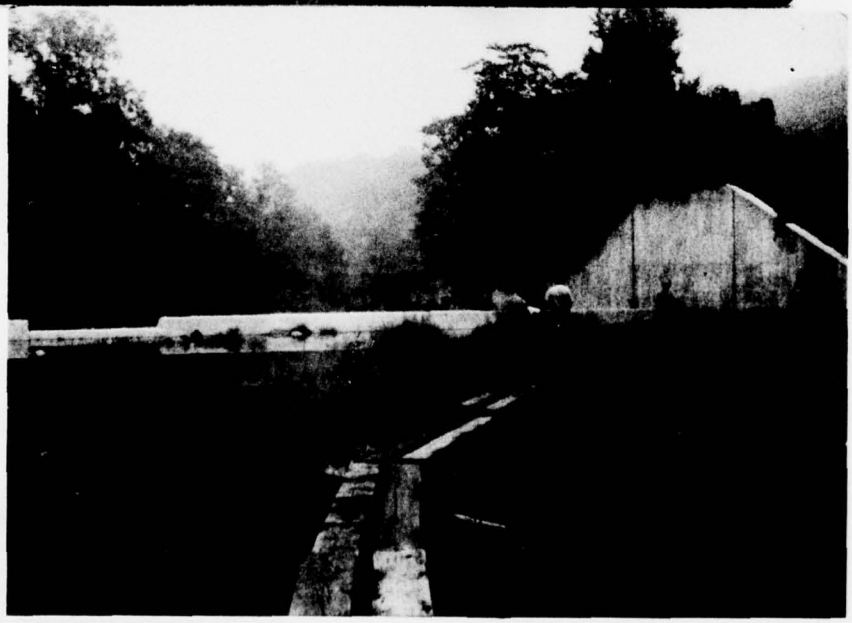


VICINITY MAP
U.S.G.S. QUADRANT
BLUE RIDGE SUMMIT MD. PA.
CATOCTIN FURNACE MD.

PLATE II

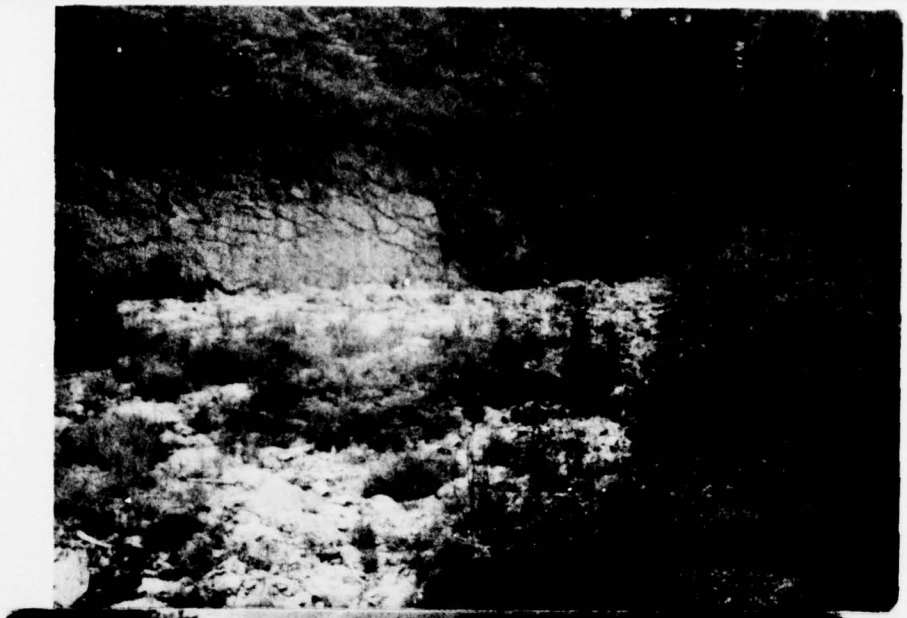
Upstream Slope &
Control Structure

Downstream Slope



Forebay and
"Floating" Boom

PLATE III

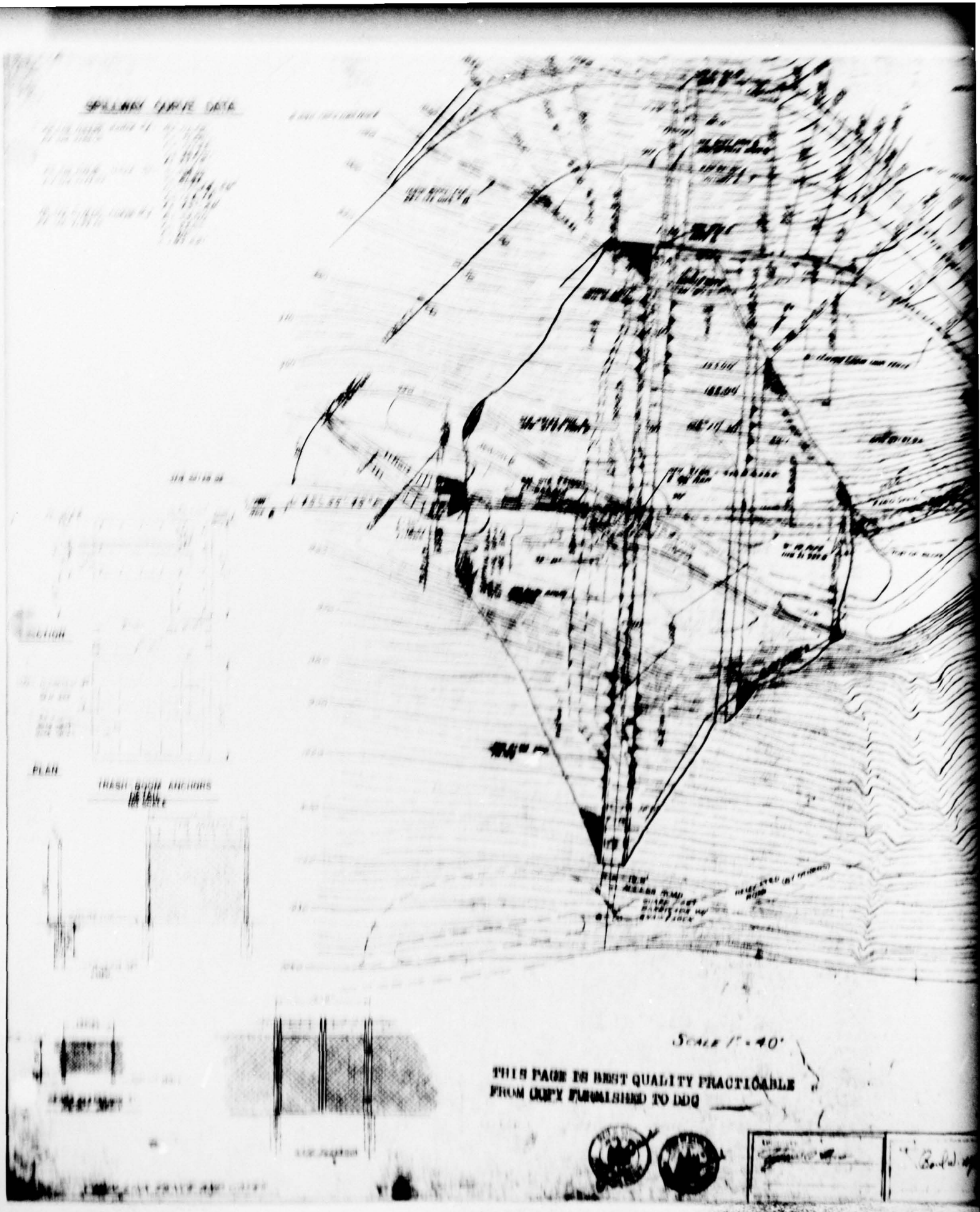


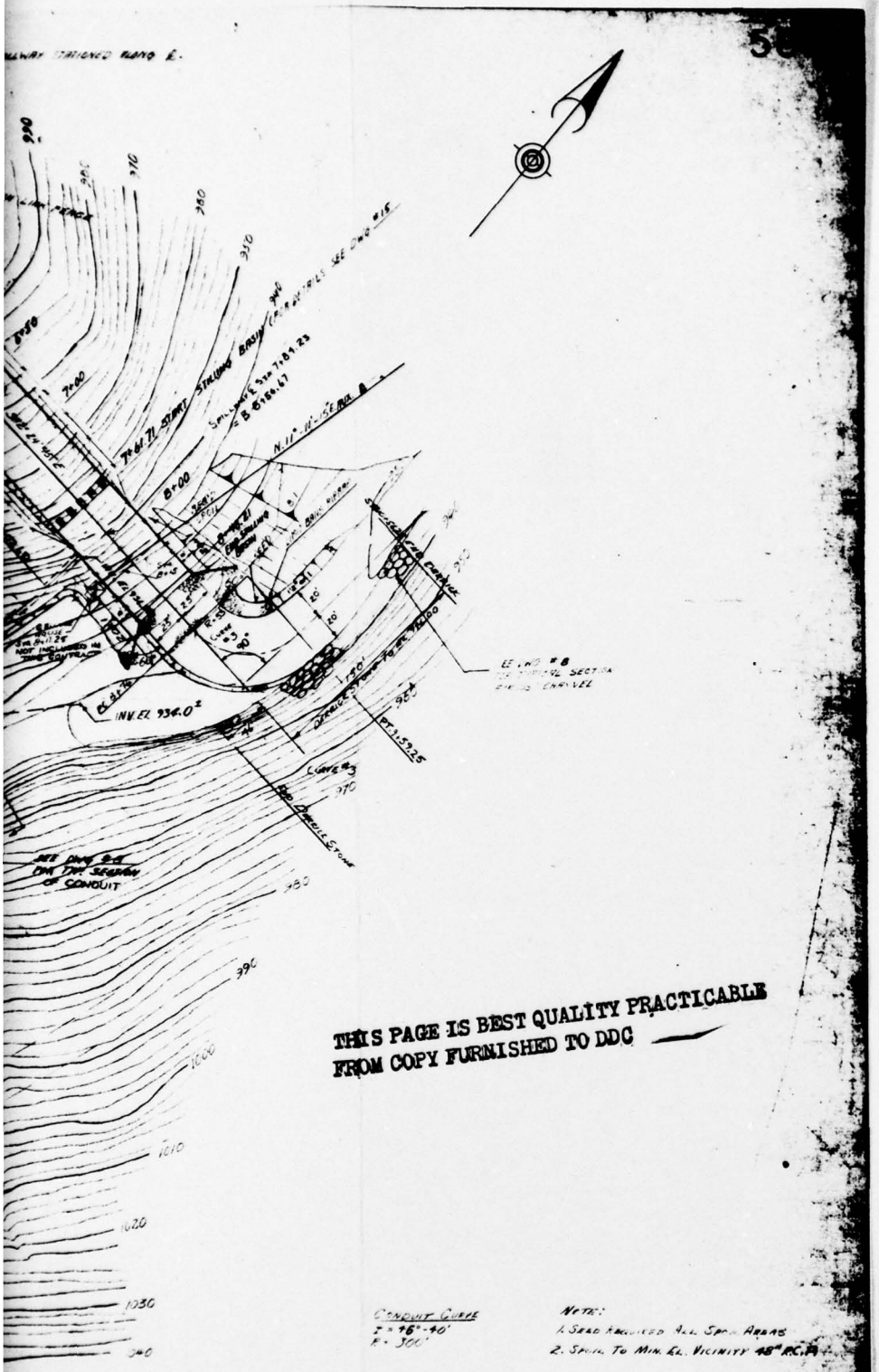
Spillway Channel

Spillway Basin &
Spillway Channel

Downstream
Channel

PLATE IV





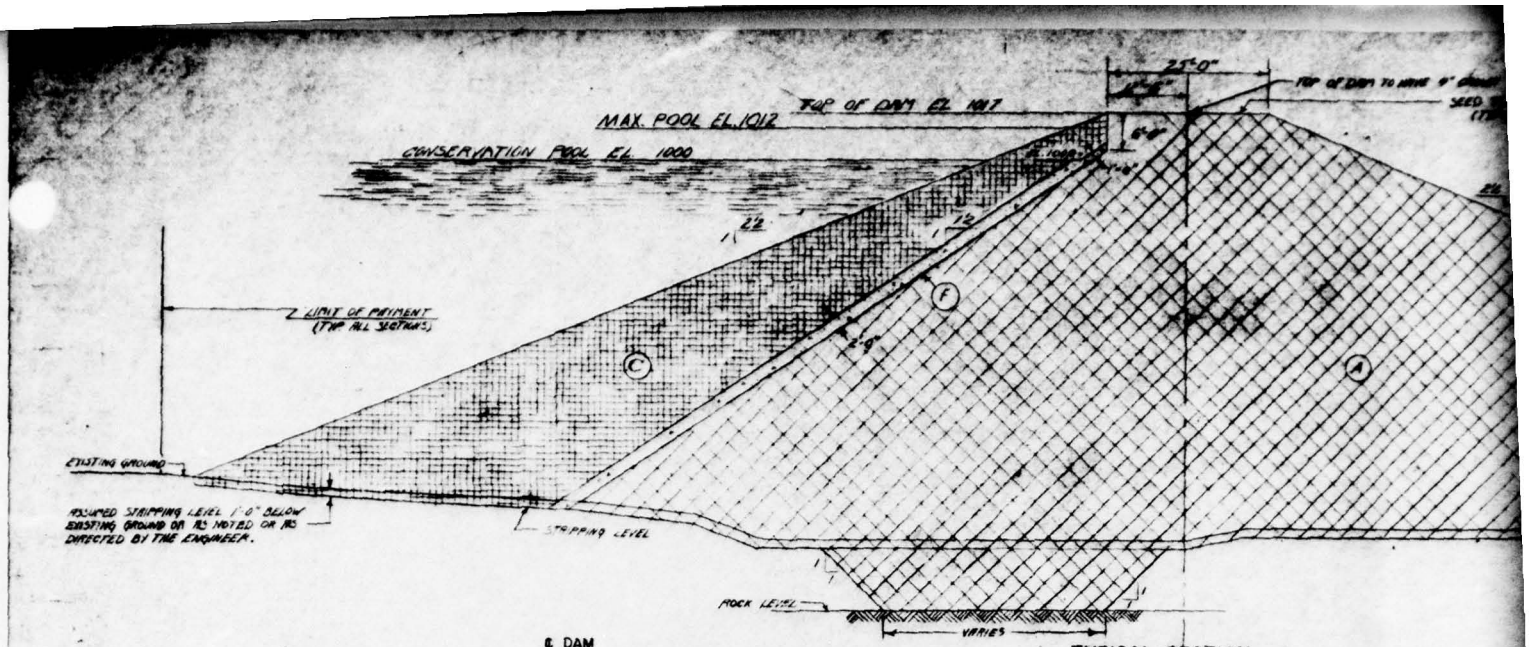
CONDUIT CURVE
$\Delta = 96°-40'$
$R = 300'$

NOTES:
1. SEED REQUIRED ALL SPOIL AREAS
2. SPOIL TO MIN. EL. VICINITY 48" R.C.P.

PLATE V

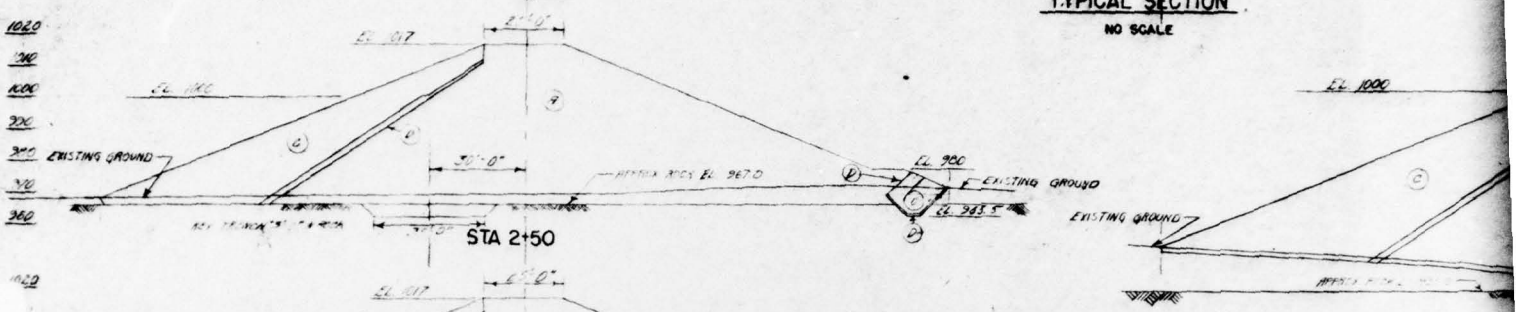
BUCHART • HORN
consulting engineers and planners
BALTIMORE, MARYLAND

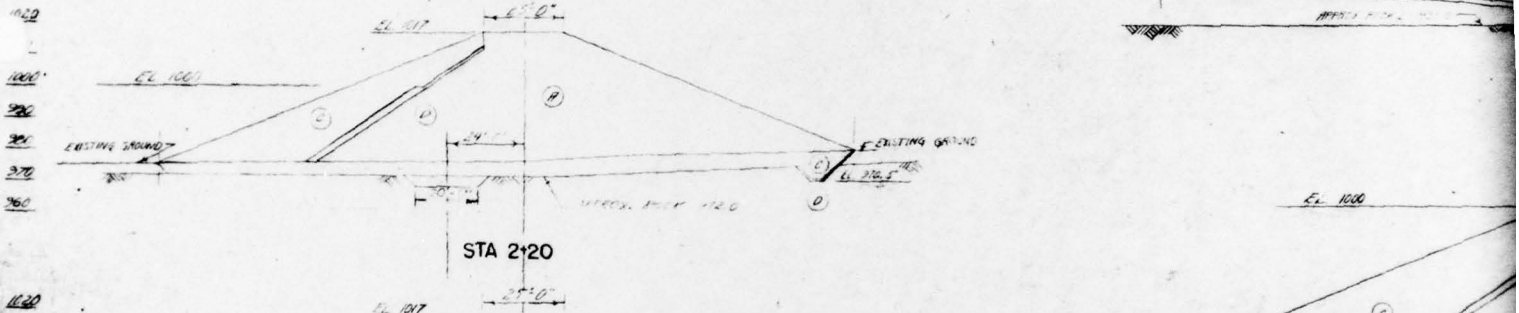
REVISIONS	GENERAL PLAN
1. TYP. SECTION OF CONDUIT ARROWS REV.	
2. TOP OF SLOPE LABELED	
3. 37+ NOTED AT START OF WALL	
4. 98' DIM. TAKEN OFF NEAR OGEE	
5. ACCESS ROAD LABELED	
REVISIONS MADE 8-29-67	

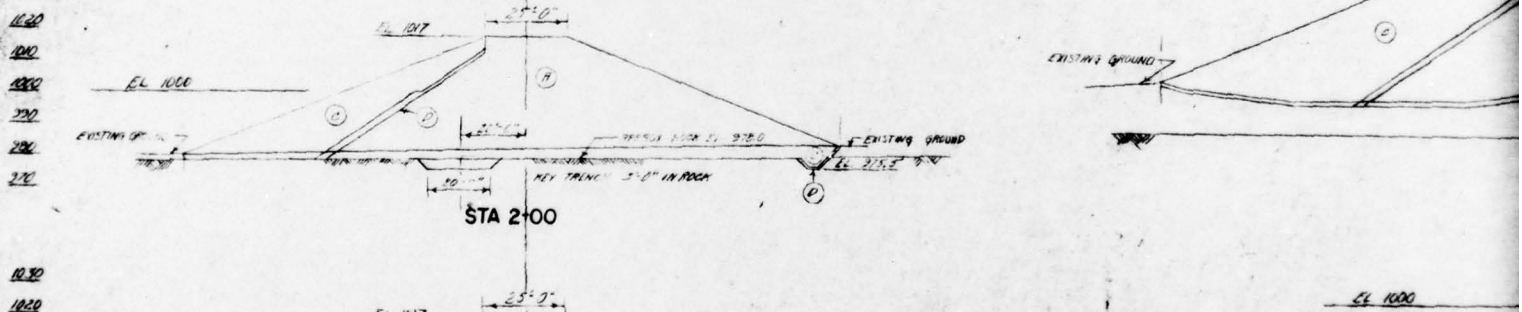


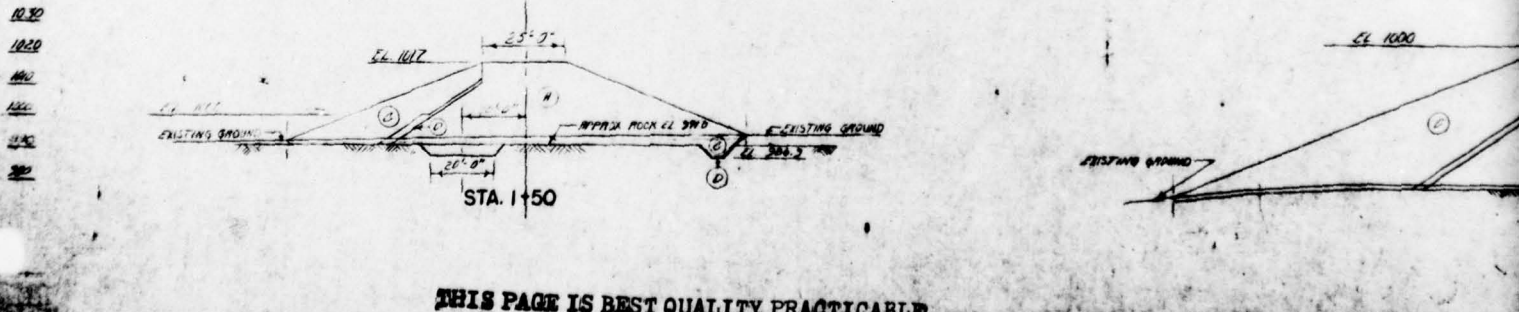
TYPICAL SECTION

NO SCALE









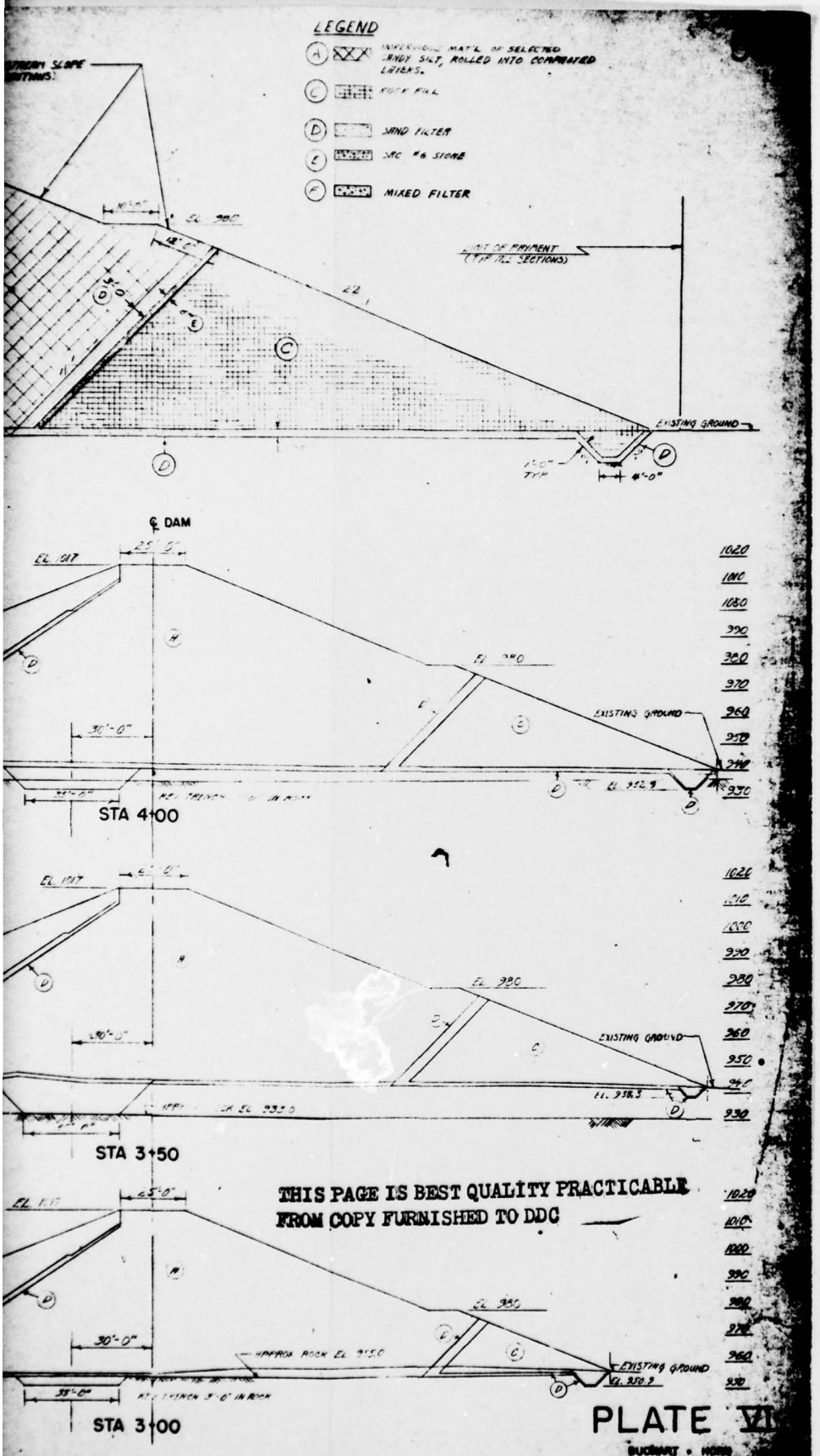
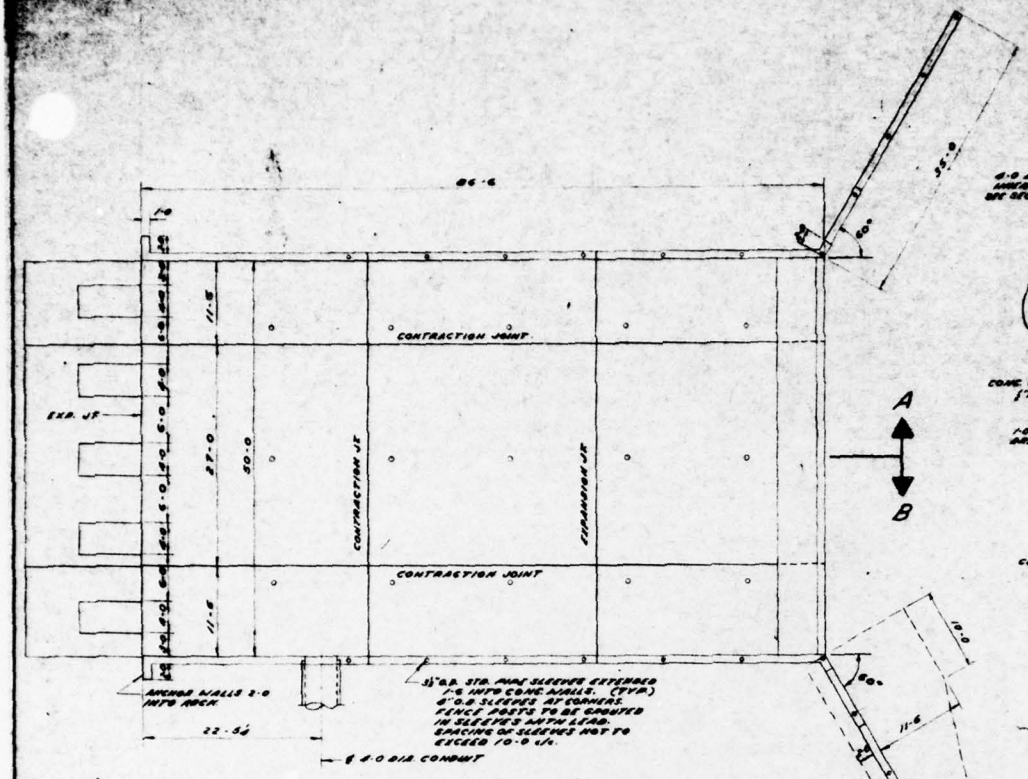


PLATE VI

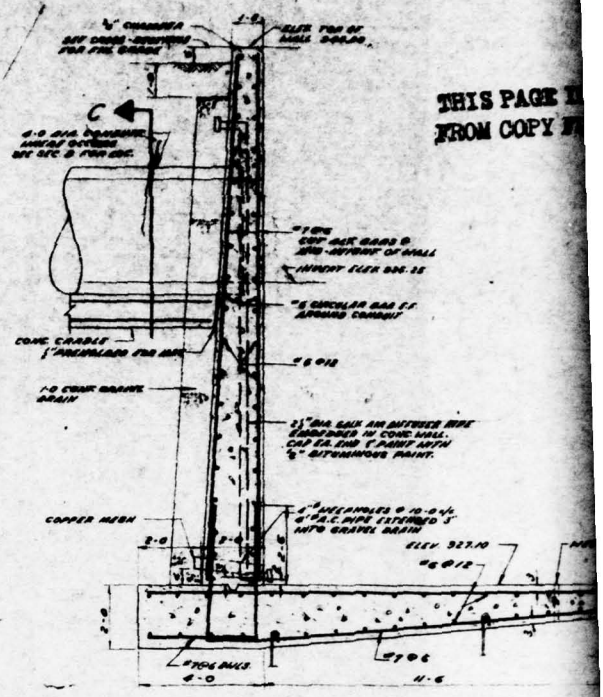
BUCHART • HORN

APPROVED	REVISIONS	EMBANKMENT SECTIONS
	1. DRAWING CHANGED PER AS BUILT CONDITIONS J.R. ~ E.E.C. 8-29-91	



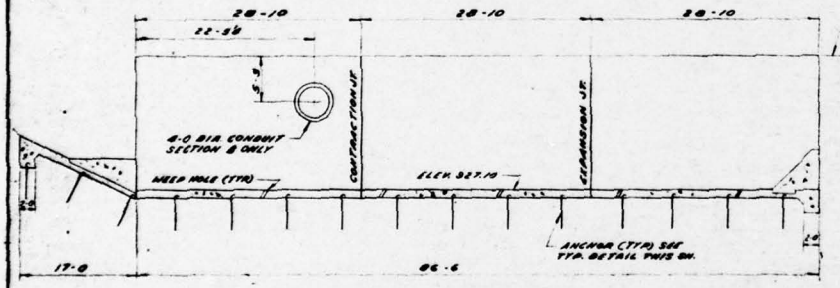
PLAN OF STILLING BASIN

SCALE: 1/8" = 1'-0"



TYPICAL SECTION THRU STILLING BASIN

SCALE: 1/2" = 1'-0"

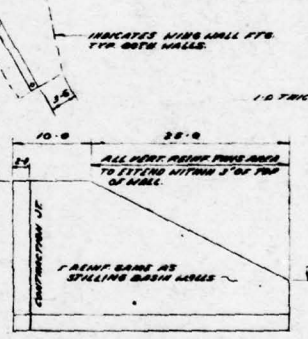


SECTION A

SCALE: 1/2" = 1'-0"

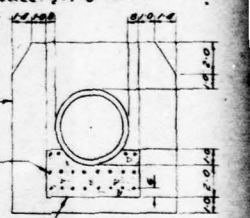
NOTE: SECTION B SAME EXP. AND CONTR. JOINTS EXCEPT AS NOTED. DRILL 3" DIA. WEEP HOLES THRU SLAB & 3" DIA. DRAINAGE HOLES 5'-0 INTO ROCK. FILL DRAINAGE HOLES WITH GRAVEL. HOLES TO BE DRILLED IN ROCK THRU UNWEATHERED CLAY SEAMS, AFTER SLAB IS POURED. HOLES TO BE APPROX. 15'-0 C/C EACH WAY.

ALL WALL FTGS. TO EXTEND A MIN. OF 6" INTO ROCK.



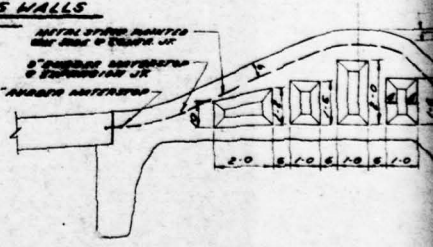
ELEVATION OF WING WALLS

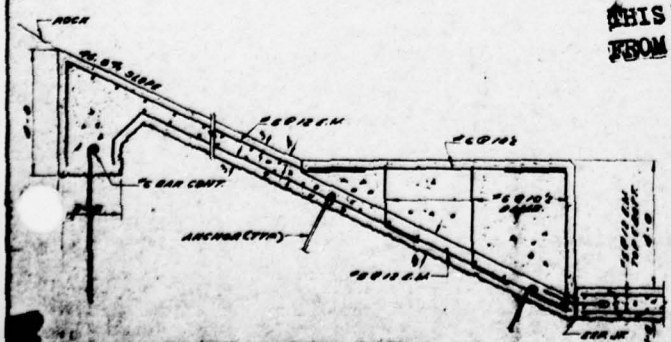
SCALE: 1/2" = 1'-0"



SECTION C

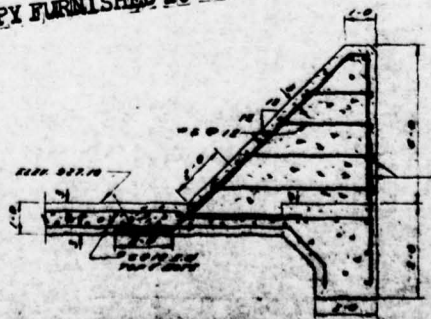
SCALE: 1/2" = 1'-0"





CHUTE BLOCK DETAIL

SCALE: 1/2" = 1'-0"



END SILL DETAIL

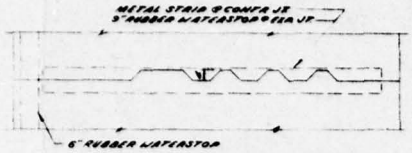
SCALE: 1/2" = 1'-0"

EXPANSION JOINT & CONTRACTION JOINT MAIN OGEE SECTION

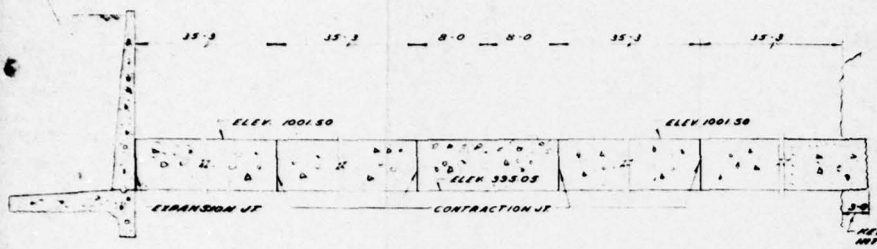
SCALE: 1/2" = 1'-0"

KEY: KEYED JOINTS WITH 6" BITUMINOUS PAINT

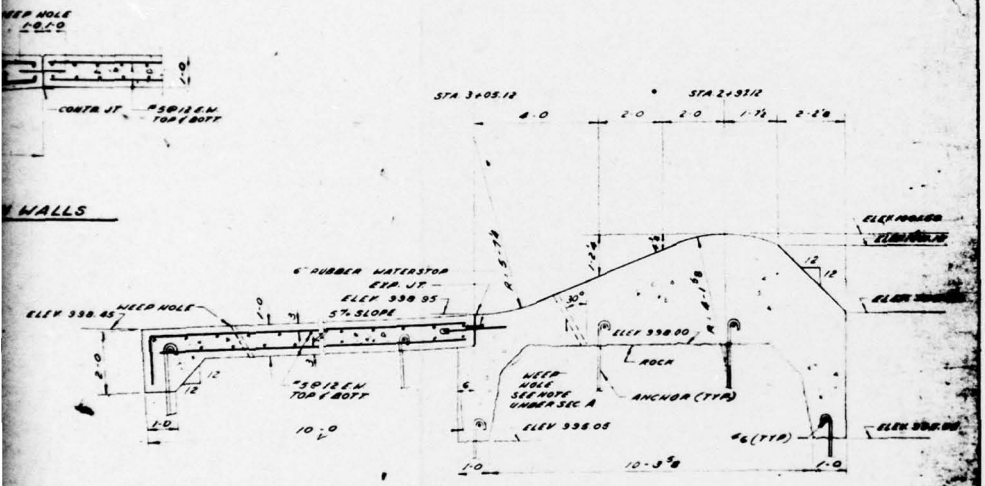
NOTE: ALL REINFORCING TO HAVE A MIN. 2" CONC. COVER EXCEPT AS NOTED. ALL CONC. TO BE CLASS 'A' EXCEPT THE CREST WHICH SHALL BE CLASS 'B'



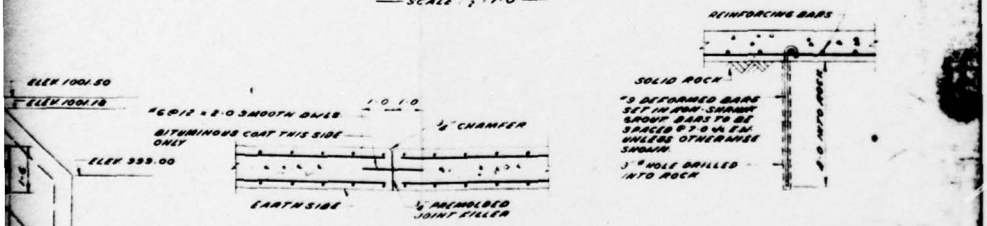
PLAN OF MAIN OGEE JOINTS
SCALE 1/2" = 1'-0"



ELEVATION OF OGEE
NO SCALE



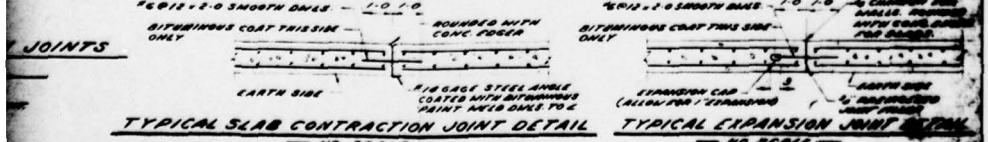
MAIN OGEE SECTION
SCALE 1/2" = 1'-0"



TYPICAL WALL CONTRACTION JOINT DETAIL
NO SCALE

TYPICAL ANCHOR DETAIL
NO SCALE

JOINTS



TYPICAL SLAB CONTRACTION JOINT DETAIL
NO SCALE

TYPICAL EXPANSION JOINT DETAIL
NO SCALE

PLATE VII

BUCHART • HORN
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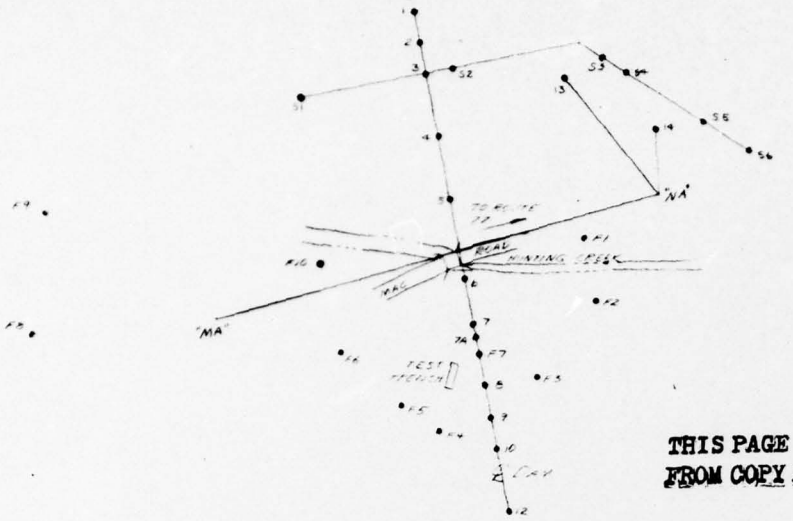
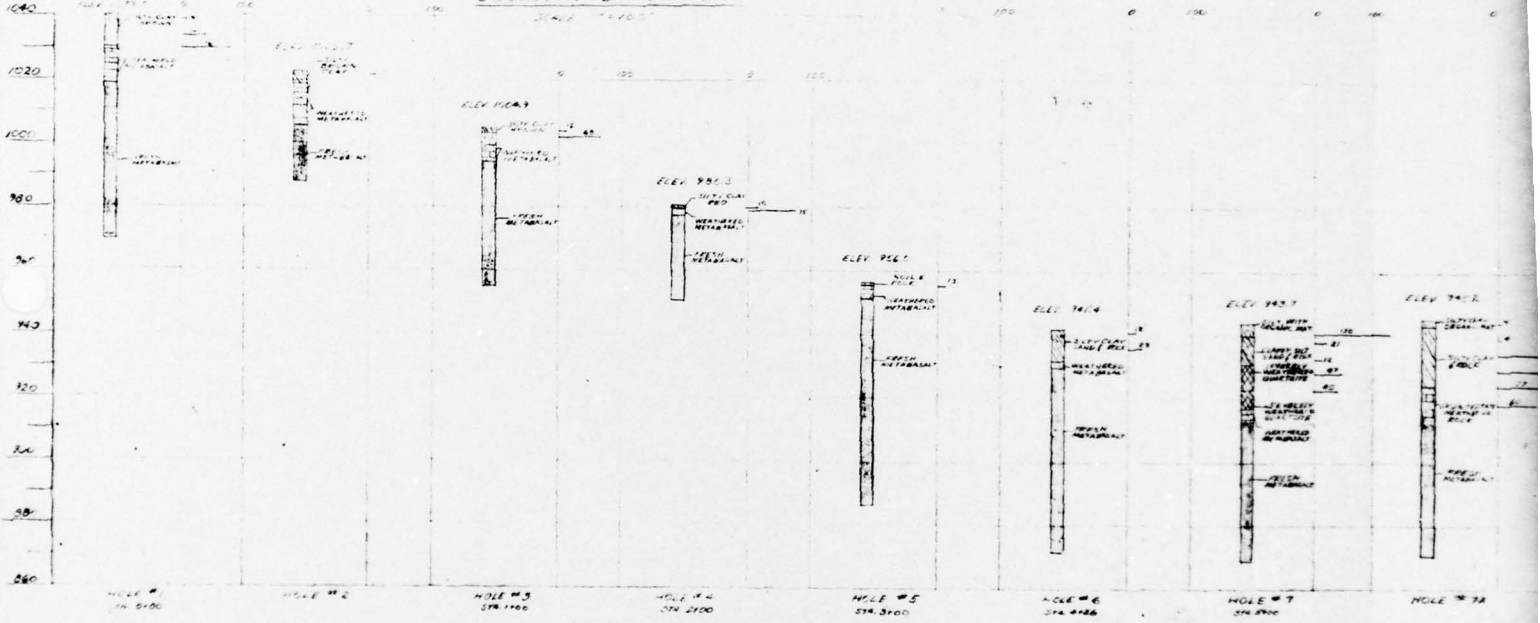
BALTIMORE, MARYLAND

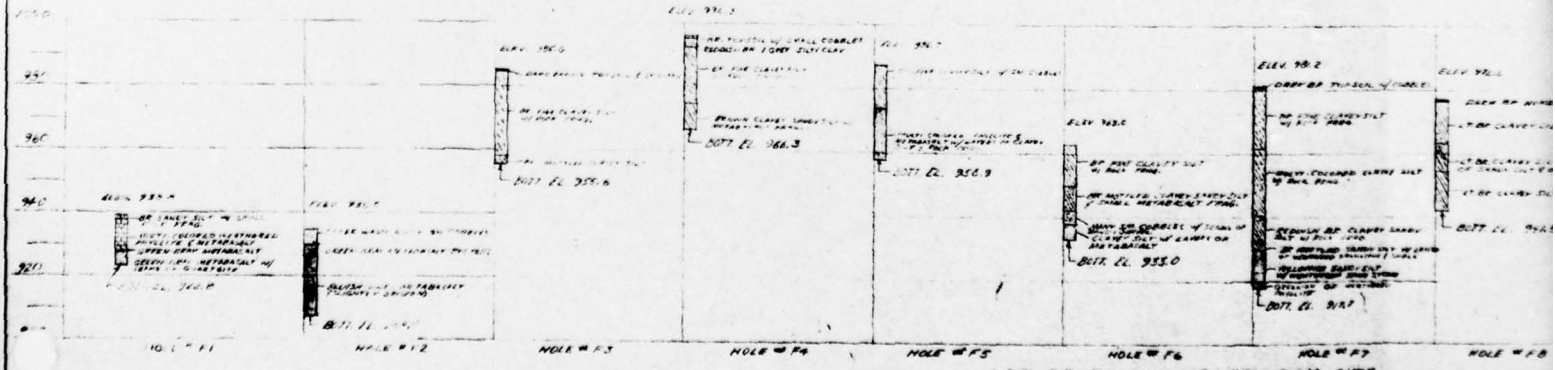
REVISIONS
1. DWG. PER AS BUILT CONDITIONS JR. 6-2-71 3-29-71

STILLING BASIN AND OGEE DETAILS



LOCATION PLAN DAM SITE





LOG OF DRILL HOLES - DAM SITE

SCALE 1" = 20' VERT.

APPROVED

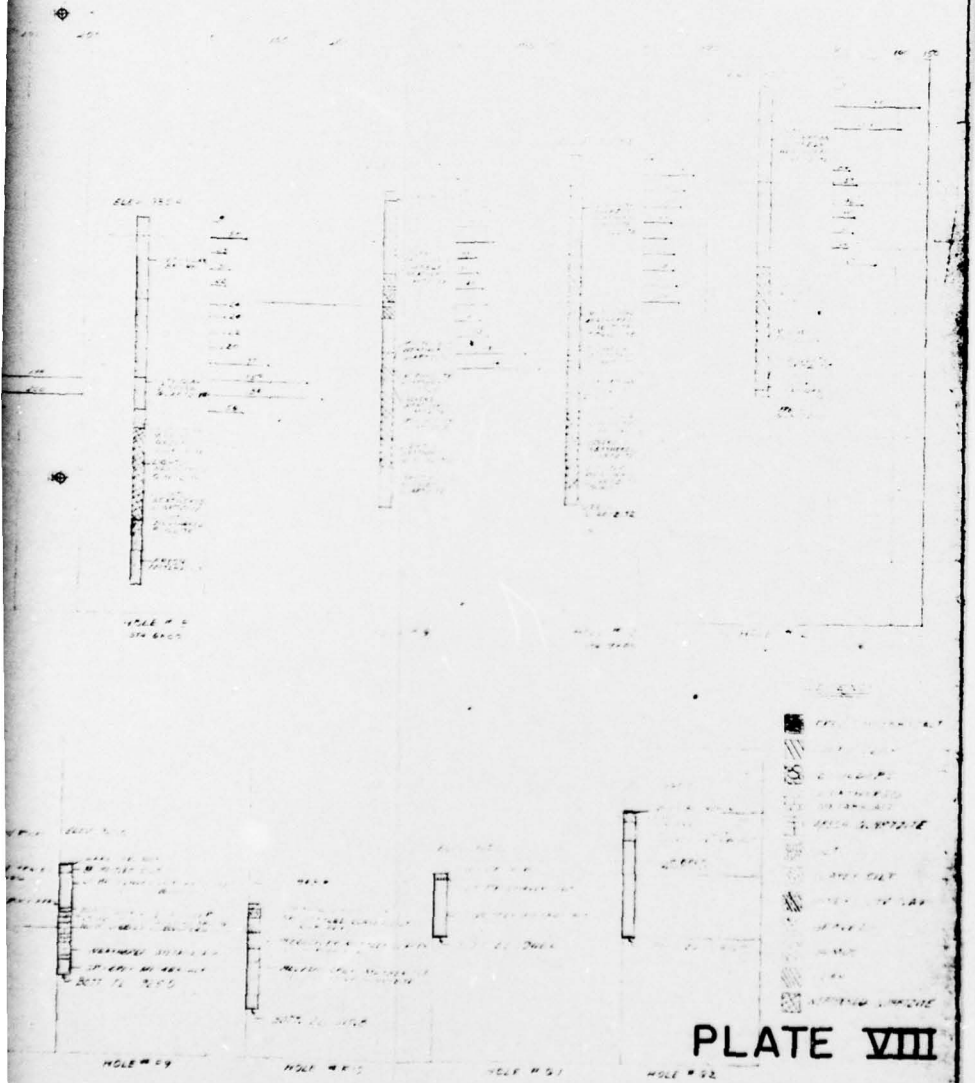


PLATE VIII

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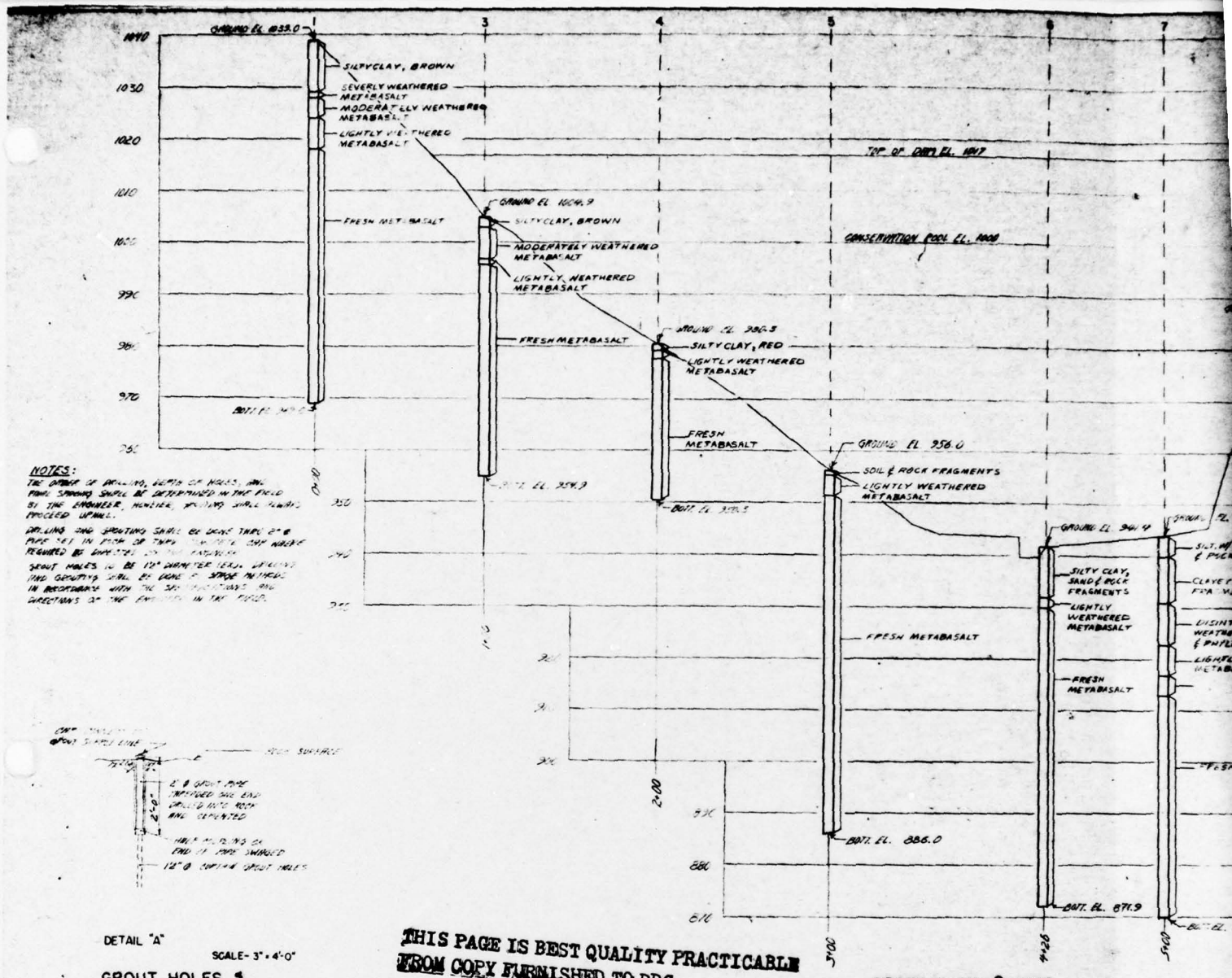
BALTIMORE, MARYLAND

REVISIONS
1 DWG PER AS BUILT CONDITION
GC 3-29-71

SUBSURFACE EXPLORATION



NOTES:
THE DEPTH OF DRILLING, DEPTH OF HOLES AND FINAL SPACING SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER. HOWEVER, DRILLING SHALL ALWAYS PROCEED UPHILL.

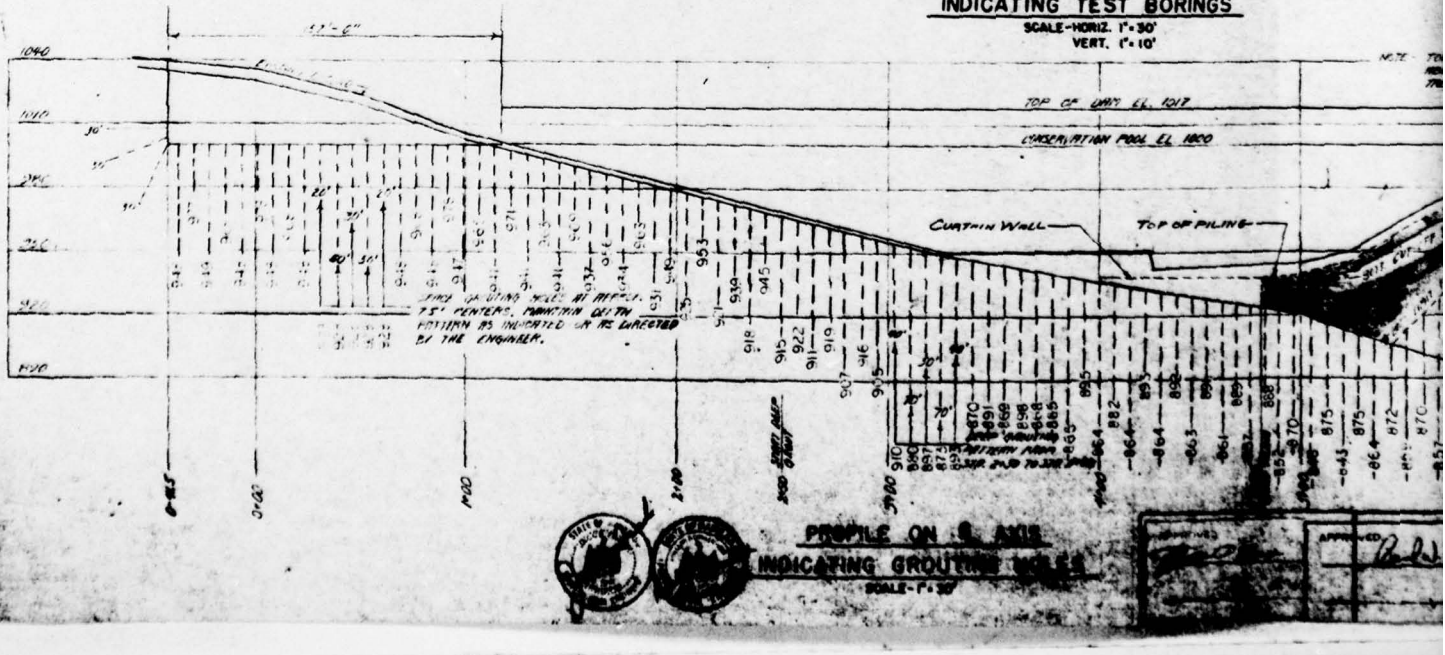
DRILLING AND GROUTING SHALL BE DONE THRU 2" Ø PIPE SET IN ROCK OR THRU [illegible] AS REQUIRED BY CONDITIONS ENCOUNTERED.

GROUT HOLES TO BE 12" DIAMETER (EXCEPT AS NOTED) AND GROUTING SHALL BE DONE IN STAGES IN ACCORDANCE WITH THE SPECIFICATIONS AND DIRECTIONS OF THE ENGINEER IN THE FIELD.

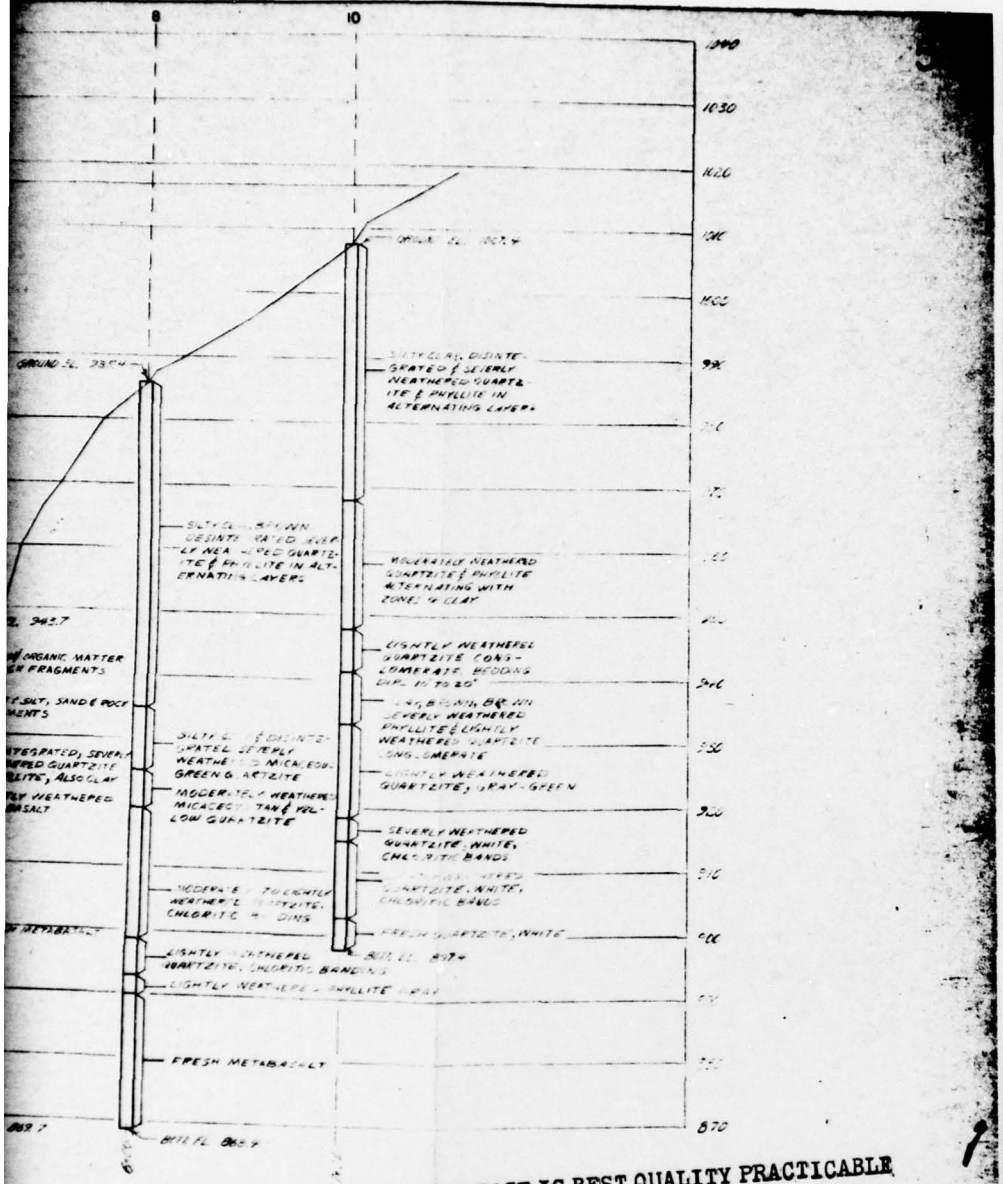
DETAIL "A"
SCALE- 3" = 1'-0"

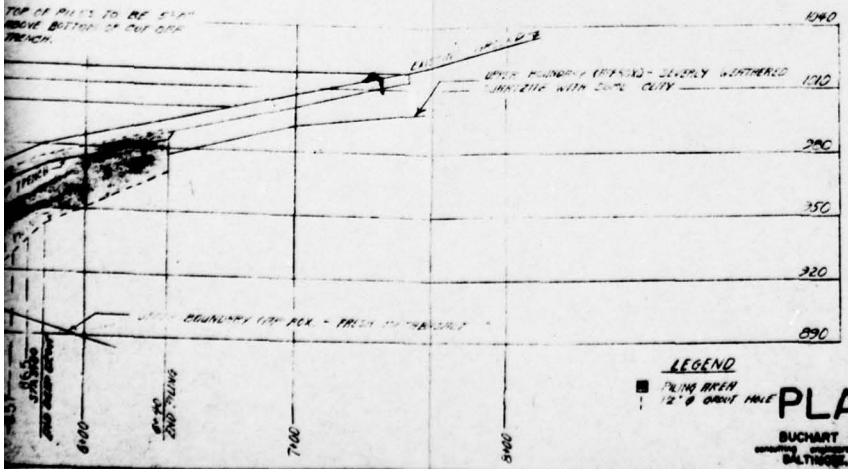
GROUT HOLES

PROFILE ON ℄ AXIS
INDICATING TEST BORINGS
SCALE-HORIZ. 1" = 30'
VERT. 1" = 10'



PROFILE ON ℄ AXIS
INDICATING GROUTING HOLES
SCALE- 1" = 30'





LEGEND
PILING AREA
12" Ø GROUT HOLE

PLATE I

BUCHART • HORN

APPROVED

REVISIONS
AS BUILT CONDITIONS
JR - G.C. 23-29-71

SUBSURFACE PREPARATION

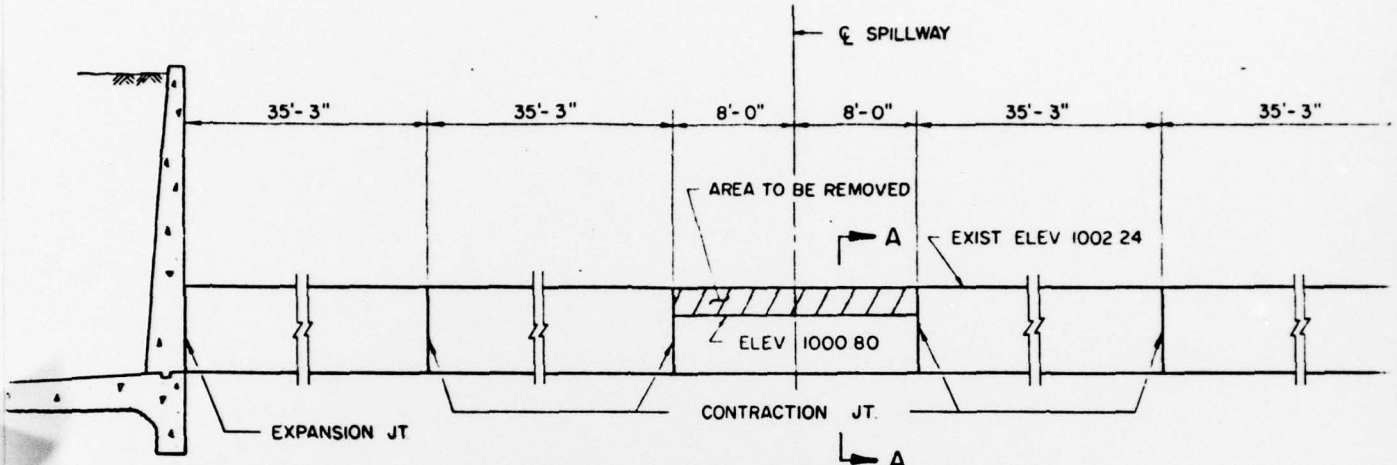
OGEE REVISIONS

(BASE BID)

CUNNINGHAM FALLS STATE PARK

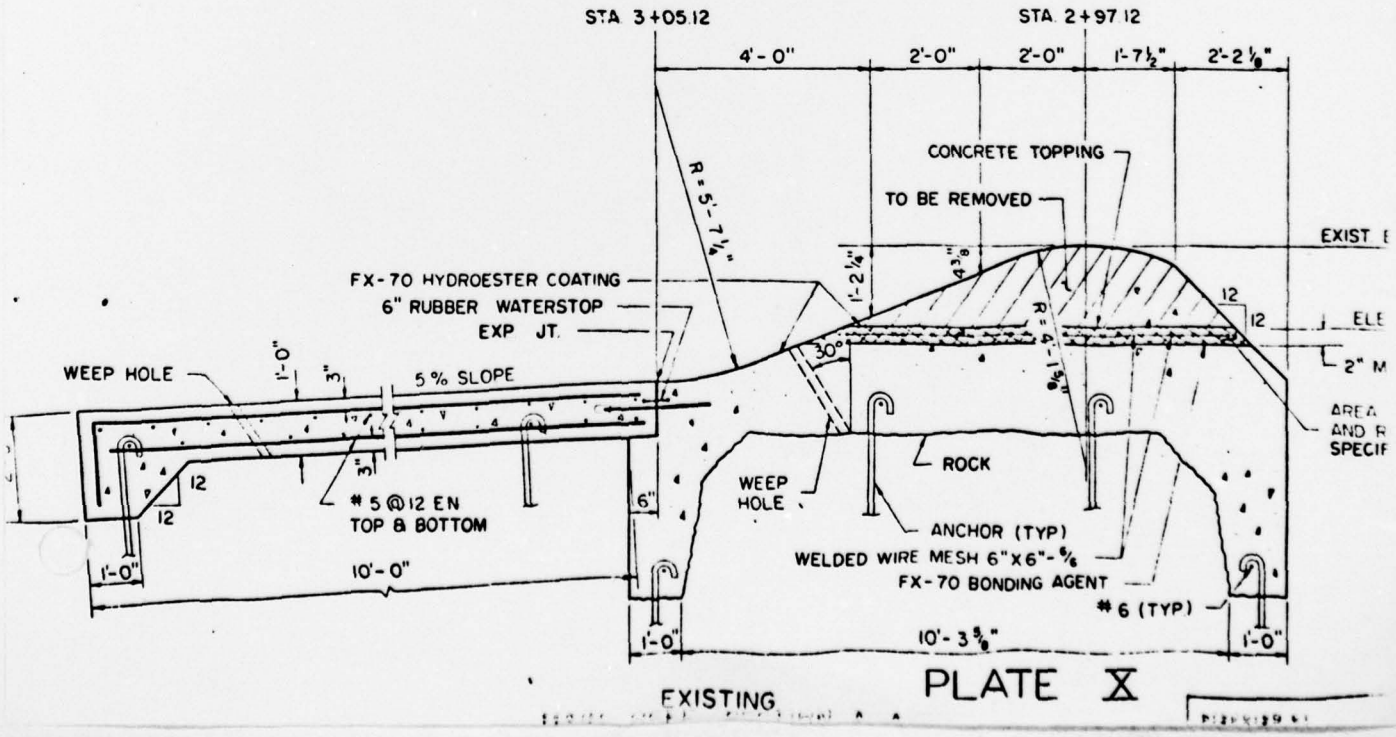
JOB NO. P-16-722

ADD. - 1



EXISTING
ELEVATION OF OGEE
NO SCALE

NOTE
1. SHADED AREA OF OGEE TO BE REMOVED



EXISTING

PLATE X